

Southwest Division
Naval Facilities Engineering Command
Contracts Department
1220 Pacific Highway, Building 127, Room 112
San Diego, California 92132-5190

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CONTRACT NO. N68711-98-D-5713
CTO No. 0072

FINAL
SITE-SPECIFIC HEALTH AND SAFETY PLAN
Revision 0
June 29, 2004

METAL DEBRIS REEF AND METAL SLAG AREAS
PARCEL E, HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA

DCN: FWSD-RAC-04-2236

Prepared by:



TETRA TECH FW, INC.

1230 Columbia Street, Suite 500
San Diego, CA 92101

Roger N Margotto

Roger Margotto, CIH
Project Environmental and Safety Manager

Abid Loan

Abid Loan
Metal Reef/Slag Project Manager



TETRA TECH FW, INC.

June 29, 2004
FWSD-RAC-04-2236
5.0

Naval Facilities Engineering Command
Southwest Division
Attn: Ms. Jan Corbett (03EM1)
1220 Pacific Highway
San Diego, CA 92132-5190

SUBJECT: FINAL SITE-SPECIFIC HEALTH AND SAFETY PLAN FOR METAL REEF AND METAL SLAG AREAS, REVISION 0, PARCEL E, HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA.

Reference: Contract N68711-98-D-5713, Environmental Remedial Action Contract
For Sites Southern California, Arizona, New Mexico, and Southern Nevada

Dear Ms. Corbett:

Please find enclosed, the Final Site-Specific Health and Safety Plan for Metal Reef and Metal Slag Areas, Revision 0, dated June 29, 2004 for Parcel E, Hunters Point Shipyard, San Francisco, California. If you have any questions or require additional information, please contact me at (949) 756-7514.

Sincerely,

Abid Loan, P.E.
Project Manager

Enclosures: Final Site-Specific Health and Safety Plan



TETRA TECH FW, INC.

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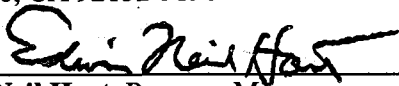
TO: Contracting Officer
Naval Facilities Engineering Command
Southwest Division
Ms. Beatrice Appling, 02R1.BA
1220 Pacific Highway
San Diego, CA 92132-5190

DATE: 06/28/04

CTO: 0072

LOCATION: Hunters Point Shipyard

FROM:


Neil Hart, Program Manager

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NAVY:

M. Gelsinger (06CH.MG) O
P. Brooks (06CH.PB) 1C/1E
J. Corbett (3EN.JC) 1C/1E
J. Payne (06CH.JP) 1C/1E
D. Silva (05G.DS) 3C/3E
Basic Contract File (02R1)
1C

TtFW:

C. Stanfield
D. Cassell
M. Schneider
U. Trulsson Messer
L. Rivero
A. Loan
J. Oslick
B. Williams / R. Margotto
G. Slattery / R. Quinn
Library Copy

OTHER: (Distributed by TtFW)

P. Stroganoff - ROICC - HPS

Date/Time Received

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ABBREVIATIONS AND ACRONYMS

AHA	Activity Hazard Analysis
AIHA	American Industrial Hygienist Association
AL	action level
amsl	above mean sea level
Base-wide Plan	Base-wide Health and Safety Plan
Cal/EPA	California Environmental Protection Agency
CHEMTREC	Chemical Transportation Emergency Center
CIH	Certified Industrial Hygienist
CNS	Central Nervous System
CSO	Caretaker Site Office
CSP	Certified Safety Professional
CTO	Contract Task Order
CVS	cardiovascular system
dBA	decibels, A-scale
DDT	dichlorodiphenyltrichloroethane
DON	Department of the Navy
EMS	Emergency Medical System
EPA	U.S. Environmental Protection Agency
ER-M	effects range-median
ft ²	square feet
FWENC	Foster Wheeler Environmental Corporation
HPAL	Hunters Point Ambient Level
HPS	Hunters Point Shipyard
mg/m ³	milligrams per cubic meter
MSDS	Material Safety Data Sheet
PCB	polychlorinated biphenyl
PEL	permissible exposure limit
PESM	Project Environmental and Safety Manager
PPE	personal protective equipment
ppm	parts per million

ABBREVIATIONS AND ACRONYMS

(Continued)

PRG	Preliminary Remediation Goal
RAC	Remedial Action Contract
RCRA	Resource Conservation and Recovery Act
ROICC	Resident Officer in Charge of Construction
RPM	Remedial Project Manager
N/A	not applicable
RWQCB	Regional Water Quality Control Board
SHSP	Site-Specific Health and Safety Plan
SHSS	Site Health and Safety Specialist
SRSO	Site Radiation Safety Officer
STEL	short-term exposure limit
SWDIV	Southwest Division Naval Facilities Engineering Command
TCRA	time-critical removal action
TLV	threshold limit value
Triple A	Triple A Machine Shop
TtEMI	Tetra Tech EM, Inc.
TtFW	Tetra Tech FW, Inc.
TWA	time-weighted average
USCG	United States Coast Guard

1.0 INTRODUCTION

This Site-Specific Health and Safety Plan (SHSP) establishes the procedures and methods to be employed for the site investigation activities that will be conducted prior to implementation of a time-critical removal action (TCRA) for removing metal slag and debris and radiological sources from the metal debris reef and the metal slag areas within Parcel E, located at Hunters Point Shipyard (HPS), San Francisco, California (Figure 1-1). The Department of the Navy (DON), Southwest Division Naval Facilities Engineering Command (SWDIV), has directed Tetra Tech FW, Inc. (TtFW), formerly Foster Wheeler Environmental Corporation (FWENC), to perform the site characterization work and subsequent TCRA for SWDIV under Remedial Action Contract (RAC) No. N68711-93-D-5713 and Contract Task Order (CTO) No. 0072. The Contract Health and Safety Program for this work consists of this document; the *Base-Wide Health and Safety Plan* (Base-Wide Plan) (TtFW, 2004a), which provides the overall framework and basic criteria for the implementation of health and safety measures for HPS; and the TtFW *Corporate Health and Safety Program Manual*.

1.1 PROJECT OBJECTIVES AND SCOPE

The objectives of the activities for this project are to assess the lateral and vertical extent of the metal slag and debris at the metal debris reef and metal slag areas and to determine the type and design of engineering controls required to manage sediment dispersion during implementation of the TCRA. The scope of work to be performed for the characterization of the metal debris reef and metal slag areas consists of the following field activities:

- Performance of topographical and bathymetric surveys, including preparation of contour maps of the offshore and upland areas.
- Execution of landside and marine geophysical surveys and correlation of the geophysical results with the site topography to select representative locations for placement of area and perimeter borings.
- Collection of split-spoon and/or continuous core samples, including conducting radiological screening of each boring location and its vicinity prior to drilling.
- Completion of downhole geophysical surveys within impacted areas of the metal debris reef and metal slag areas to measure the thickness of metallic or slag-containing horizons.

1.2 APPLICATION

This SHSP will be used in conjunction with the Base-Wide Plan (TtFW, 2004a) and is applicable to all work conducted under the basic contract and this CTO. Refer to the Base-Wide Plan (TtFW, 2004a) for additional details common to all work performed at HPS. Equivalent or additional health and safety procedures and practices may be approved by TtFW and implemented where necessary. All project personnel are required to follow the health and safety programs and procedures discussed herein unless changes are approved by the Project Environmental and Safety Manager (PESM), who is a Certified Industrial Hygienist (CIH), and the DON Contracting Officer. The PESH will review all applicable SHSPs prior to initiation of field activities.

1.3 SUMMARY OF MAJOR RISKS

The potential project hazards associated with the site characterization activities consist of physical, chemical, and radiological hazards. Physical hazards include the following:

- Use of and working around heavy equipment
- Hazards associated with using drilling equipment
- Handling of soil cores and samples collected during drilling
- Working on or near water with hazardous currents
- Slips, trips, and fall hazards associated with working on uneven and sloped terrain

The chemical hazards include exposure to contaminated soil and sediments. During previous site investigations, sediments near the metal debris reef were found to contain metals, polychlorinated biphenyls (PCBs), and pesticides at concentrations exceeding effects range-median (ER-M) sediment screening criteria [Tetra Tech EM, Incorporated (TtEMI), 2002]. The metals detected in sediment samples from the metal debris reef area at concentrations exceeding the Hunters Point Ambient Levels (HPALs) or Preliminary Remediation Goals (PRGs) are antimony, arsenic, beryllium, cadmium, cobalt, copper, lead, manganese, mercury, molybdenum, nickel, silver, vanadium, and zinc. Dioxins have been detected in soil at the burn disposal area near the metal debris reef and may also be present in the metal debris reef area.

Within the metal slag area, sediment tests have resulted in metals at concentrations exceeding ER-M sediment screening criteria (TtEMI, 2002). The metals detected in sediment samples from the metal slag area at concentrations exceeding the HPALs or PRGs are antimony, arsenic, copper, lead, manganese, molybdenum, and zinc.

Anyone that enters the work area must be trained on the Material Safety Data Sheets (MSDSs) provided in Attachment 1, and become familiar with the precautions that are associated with the above chemicals.

The radiological hazards include exposure to radium-containing devices within the metal debris reef and the metal slag areas. During previous site investigations, one elevated reading was detected near the burn disposal area within the metal debris reef area, five elevated readings were detected by Berth 36 in the metal debris reef area, and seven elevated readings were noted in the metal slag area, indicating that radium-containing devices may be present within both areas (TtEMI et al., 1997). A shoreline gamma survey, performed in June and July of 2001, indicated that the metal debris reef and metal slag areas contain sources of radiation at greater than twice the background concentration.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

The following list identifies the key contacts for those agencies and individuals that are responsible for the oversight and/or implementation of the characterization activities. A project organization chart showing the relationship among select team members is provided as Figure 2-1.

Agency	Contact	Project Title
SWDIV 1230 Columbia Street San Diego, CA 92101	Jose Payne (619) 532-0962	SWDIV Remedial Project Manager (RPM)
ROICC San Francisco Bay Area 2450 Saratoga Ave., Suite 200 Alameda, CA 94501	Peter Stroganoff (510) 749-5941	Resident Officer in Charge of Construction (ROICC) Project Engineer
ROICC San Francisco Bay Area 2450 Saratoga Ave., Suite 200 Alameda, CA 94501	Andy Uehisa (510) 749-5946	ROICC Construction Management Technician
CSO Hunters Point Shipyard 410 – Palm Avenue, Building 1, Suite 161 San Francisco, CA 94130	Mike Mentink (415) 743-4729	Caretaker Site Office (CSO)
CSO Hunters Point Shipyard 410 – Palm Avenue, Building 1, Suite 161 San Francisco, CA 94130	Doug Delong (415) 743-4713	CSO
U.S. Environmental Protection Agency (EPA), Region IX 75 Hawthorne Street San Francisco, CA 94105-3901	Michael Work (415) 972-3024	EPA
California Environmental Protection Agency Department of Toxic Substances Control Office of Military Facilities 700 Heinz Ave., Bldg. F, Suite 200 Berkeley, CA 94710	Tom Lamphan (510) 540-2122	California Environmental Protection Agency (Cal/EPA) RPM
California Regional Water Quality Control Board 1515 Clay Street, Suite 1400 Oakland, CA 94312	Jim Ponton (510) 662-2300	Regional Water Quality Control Board (RWQCB) RPM
TtFW 1940 East Deere Avenue, Suite 200 Santa Ana, CA 92705	Jamshid Sadeghipour (949) 756-7519	Deputy Program Manager
TtFW 1230 Columbia Street, Suite 500 San Diego, CA 92101	C.H. Stanfield (619) 471-3517	HPS Program Manager

Agency	Contact	Project Title
TtFW 1940 East Deere Avenue, Suite 200 Santa Ana, CA 92705	Abid Loan (619) 471-3502	Metal Reef/Slag Project Manager
TtFW 1940 E. Deere Avenue, Suite 100 Santa Ana, CA 92705	Jeff Oslick (949) 756-7513	Assistant Project Manager/ Technical Lead
TtFW 1940 East Deere Avenue, Suite 100 Santa Ana, CA 92705	Mary Schneider (949) 756-7586	Quality Control Program Manager
TtFW Hunters Point Shipyard 270 Nimitz Avenue, Building 270 San Francisco, CA 94124	Bill Williams (415) 671-1990	Construction Manager/ Site Superintendent
TtFW Hunters Point Shipyard 270 Nimitz Avenue, Building 270 San Francisco, CA 94124	Chuck Holman (415) 671-1990	Project Quality Control Manager (PQCM)
TtFW Hunters Point Shipyard 270 Nimitz Avenue, Building 270 San Francisco, CA 94124	Gene Forrer (415) 671-1990	Site Radiation Safety Officer (SRSO)
TtFW Hunters Point Shipyard 270 Nimitz Avenue, Building 270 San Francisco, CA 94124	Richard Quinn, CSP (650) 450-1969	Senior Site Health and Safety Specialist (SHSS)
TtFW 1230 Columbia Street, Suite 500 San Diego, CA 92101	Roger Margotto, CIH, CSP, CHMM (619) 471-3503	Project Environmental and Safety Manager (PESM)
TtFW 3200 George Washington Way Richland, WA 99352	Cliff Stephan, CHP (509) 372-5800	Project Certified Health Physicist

3.0 SITE HISTORY AND PROJECT DESCRIPTION

The Base-Wide Plan (TtFW, 2004a) details the description, history, and physical characteristics of HPS. The description of this specific site and duration of the project are described below.

3.1 SITE DESCRIPTION AND HISTORY

HPS is located on a long promontory in the southeastern part of San Francisco that extends east into San Francisco Bay. HPS encompasses 928 acres, including 496 acres on land. The land portion of HPS was purchased by the DON in 1939 and leased to Bethlehem Steel Corporation. At the start of World War II in 1941, the DON took possession of the property and operated it as a shipbuilding, repair, and maintenance facility until 1974. The DON deactivated HPS in 1974. From 1976 to 1986, the DON leased HPS to Triple A Machine Shop, Inc. (Triple A), a private ship repair company. In 1986, Triple A ceased operations and the DON resumed occupancy.

HPS is divided into six parcels, Parcels A through F. The activities governed by this Characterization Work Plan deal specifically with the metal debris reef and the metal slag areas, both located in Parcel E (see Figure 1-1).

From 1945 to 1948, the DON operated an open, 1-acre burn disposal area at Installation Restoration Site 02 Southeast adjacent to the metal debris reef. About 23,000 tons of domestic garbage and refuse, including metal debris, were burned at the disposal area. The metal debris reef is suspected to have originated from the burn disposal area. The metal debris reef was first identified during a standard data gaps investigation conducted in August 2002 (TtEMI, 2002). The history of the metal slag area is not well known. A foundry was believed to have been located at HPS when the shipyard was active. It is possible that the slag resulted from the pouring of foundry waste along the shoreline; however, there is no documentation of the origins of the metal slag.

3.2 SITE PHYSICAL CHARACTERISTICS

Parcel E occupies 173 acres along the upland shoreline in the southwestern portion of HPS (see Figure 1-1). The DON created this land area by filling in the bay margin, largely with serpentine bedrock quarried from the Hunters Point peninsula. The shoreline area generally consists of riprap containing rock, concrete, metal debris, metal slag and other debris, with relatively sharp slopes to the bay as well as mudflat and sandy beaches. Groundwater is located at about zero to 2 feet above mean sea level (amsl) (8 to 10 feet below ground surface), with a westward gradient toward the bay. The layer of Bay Mud deposits in the area is continuous, ranging in thickness from 1 to 41 feet and surface elevation from -5 to 6 feet amsl. The metal

debris reef is located at the southeastern end of Parcel E and the metal slag area is located at the northwestern end of Parcel E (see Figure 1-1).

3.2.1 Metal Debris Reef Area

The metal debris reef area contains metal debris and solidified residue from trash fires along the shoreline. The metal debris reef dimensions were approximated by visual observation and based on a survey conducted using a continuity meter to detect all metal near the ground surface. The area measures approximately 28,880 square feet (ft²), including a 1,000-ft² area where metal debris is not visible at the ground surface but where the continuity meter indicated the presence of subsurface metal debris. Very little information is available on the thickness of the metal debris reef. A conservative estimate of the thickness is 5 feet. The total volume of the metal debris reef is estimated at 5,400 cubic yards. The metal debris reef is below the high-tide line and in a relatively strong current area. The metal debris reef is in various states of oxidation.

3.2.2 Metal Slag Area

The area consists of metal slag along the shoreline. The slag is discontinuous and covers an area of about 12,445 ft². It is estimated that only 30 percent of the area is covered by metal slag. The vertical extent of the slag is unknown; however, a depth of 5 feet has been estimated. The metal slag area is partially covered during high tide.

3.3 PROJECT DESCRIPTION

A TCRA, which is being conducted in accordance with the Basewide Action Memorandum (SWDIV, 2001), has been initiated for this site. The Work Plan for this project has been prepared to outline the various field activities associated with characterizing the metal debris reef and metal slag areas, required in order to implement the TCRA. The specific objectives of this site characterization are to assess the lateral and vertical extent of the metal slag and debris at the metal debris reef and metal slag areas and to determine the type and design of engineering controls required to manage sediment dispersion during implementation of the TCRA.

In order to assess the lateral extent of the metal slag and debris at the metal debris reef and metal slag areas, the following field surveys will be conducted: 1) topography, 2) bathymetry, 3) landside geophysical, and 4) marine (offshore) geophysical. These surveys will be used to select locations for placement of area and perimeter borings. Area borings will be conducted using hollow-stem auger or rotary-sonic methodology. Perimeter, or offshore, borings will be conducted with either a hollow-stem auger system, which will require the use of a barge, or a vibracore system, depending on site conditions. To identify the vertical extent of metal slag and debris at the metal debris reef and metal slag areas, downhole geophysical surveys will be performed during landside boring activities in each individual borehole.

3.4 PROJECT DURATION

Site characterization activities are estimated to be completed within 2 months of the initial mobilization effort.

4.0 POTENTIAL HAZARDS

The Base-Wide Plan (TtFW, 2004a) identifies hazards that are common to all projects within HPS. Site-specific hazards associated with this project, including chemical, environmental, and physical hazards, are summarized below.

4.1 CHEMICAL HAZARDS

Based on analytical data provided by previous site investigations, the chemicals anticipated to be encountered during site characterization activities at the metal debris reef area include polychlorinated biphenyls (PCBs), pesticides, metals, and possibly dioxins. The chemicals expected to be within the metal slag area include metals. MSDSs for the contaminants and any additional chemicals found on site or brought onto the site will be acquired and reviewed with all personnel during daily safety meetings. Attachment 1 of this SHSP contains MSDSs of the anticipated contaminants. The PESM and SHSS will initially specify the levels of protection and air monitoring requirements based on the data provided or obtained prior to characterization activities. These requirements may change as site conditions are more fully evaluated. Table 4-1 summarizes the hazards associated with these chemicals.

A master file of MSDSs for chemicals at the site and any additional chemicals brought onto the site for use on this project will be kept in the HPS trailer. A copy of the MSDSs will also be maintained at the worksite and will be readily accessible at all times.

4.2 ENVIRONMENTAL HAZARDS

Projects at HPS have the potential for hazards related to temperature stresses, which are addressed in the Base-Wide Plan (TtFW, 2004a). Other environmental hazards may include excessive noise levels during drilling operations, high winds, and dangerous seas. Hearing protection will be made available to all employees exposed to noise levels above a time-weighted average (TWA) of 84 decibels, A-scale (dBA). If wind speeds are 25 miles per hour or higher, the SHSS will stop all work and assess what, if any, work activities can continue to be performed in a safe manner. The SHSS will also stop all work that must occur on water in the case of dangerous seas. Activities on water will be determined unsafe by the SHSS based on a combination of high winds and currents.

Biological hazards may include animal bites, insect stings, and contact with poison oak, animal and bird droppings, mice or rats, and snakes. Personnel will use extreme caution when working in the vicinity of potential animal habitat, such as pickleweed, wetlands, riprap, crevices, and under or behind objects.

The SHSS or Construction Manager will discuss environmental hazards associated with the site personnel at the orientation meeting prior to startup of remediation activities and during the daily safety meetings as various environmental hazards require attention.

4.3 PHYSICAL HAZARDS

There are numerous physical hazards associated with this project that, if not identified and addressed, could present accidents and personal injury to the workforce, as well as operational problems. In order to minimize the physical hazards, TtFW has developed standard safety protocols, which will be followed at all times. The health and safety rules and guidelines are presented in the TtFW Project Rules Handbook, and the physical hazards associated with most project activities at HPS are identified in the Base-Wide Plan (TtFW, 2004a). In addition to the hazards in the Base-Wide Plan (TtFW, 2004a), the following precautions should be applied when performing site characterization activities.

4.3.1 Walking Surfaces and Trip Hazards

The shoreline area of Parcel E is marked by riprap containing rock, concrete, metal debris, metal slag, and other debris, and has relatively sharp slopes to the bay. The metal debris reef area contains metal debris and solidified residue, while the metal slag area consists of metal slag along the shoreline and is partially covered during high tide. Care must be taken when walking around the site to avoid slip, trip, and fall hazards, especially during rainy or windy conditions and in locations that may be wet due to the nearby waterbody. The SHSS will inspect each work area prior to commencement of work in each area and physically mark all trip hazards. Site-specific training will be provided for hazards that cannot be marked or removed. In order to minimize tripping hazards caused by debris, job supplies, and equipment, personnel will remove these materials from the work areas daily and stockpile the materials and place equipment in storage areas. The SHSS will enforce this "housekeeping" effort throughout the day.

In addition, there are likely to be slip, trip, and fall hazards on board the work boat/barge due to wet walking surfaces, unsecured equipment left on deck, open hatches, and the pitching and rolling actions of the vessels in rough water. These hazards will be controlled by keeping the vessel decks and walkways free of debris and other litter. All open floor hatches will be closed during normal operations, and any stairways, walkways, and elevated work platforms will be equipped with guard railings. Workers will wear high-traction, steel-toed safety boots and pay careful attention to potentially hazardous surface conditions. Following daily safety inspections, the SHSS will communicate to site personnel the identification of any injury-causing hazards that may be present within the work area.

4.3.2 Working Aboard Vessels

The bathymetric survey, the marine geophysical survey, and offshore drilling will require working aboard various vessels. Small work boats and tug boats will be used to conduct surveys, collect surface water samples, inspect all waterside work activities, and either perform vibracoring or move barges, transport barge personnel to and from the shore, and set anchors, depending on site conditions. Should site conditions require the use of the hollow-stem auger over water, the auger system will be transported to a barge for operation.

Operating vessels on water carries such risks as having a crew member fall overboard and possibly drown, striking or being struck by other vessels operating in the area, losing power or steering and drifting into hazardous areas (onto shore, into marine facilities, and so forth), and encountering severe weather and dangerous seas. The risk of boating accidents will be reduced by ensuring that only experienced personnel operate vessels, operating the vessels in accordance with applicable United States Coast Guard (USCG) regulations, maintaining vessels in good mechanical order, avoiding bad weather and dangerous seas, and ensuring that emergency equipment is available on board. Emergency equipment may include life vests, life rings, lifeboats, fire extinguishers, and communication equipment.

4.3.3 Head and Back Injuries

At a minimum, workers will don hard hats, safety boots, and safety glasses prior to performing any site activities. This will reduce the likelihood of a severe injury from small falling objects and prevent minor injuries caused by bumping one's head while working around heavy equipment. Heavy lifting will be required when moving equipment and supplies, launching small boats, stowing gear, and handling testing equipment. To control this hazard, personnel will be instructed in proper lifting techniques and will not lift more than 50 pounds without the assistance from another person. Mechanical lifting equipment will be used whenever possible to minimize worker exposure to lifting hazards.

4.3.4 Radiation

Low-level radioactive materials may be present in both the metal debris reef and metal slag areas. If radioactive materials are encountered during radiological screening, the Base-Wide Plan (TtFW, 2004a) describes program requirements and general procedures. The selected subcontractor has submitted a site-specific Radiological Control Plan (RCP), included as Appendix D of the Work Plan (TtFW, 2004b), that will be followed. This RCP will be reviewed and accepted by a TtFW Certified Health Physicist and a TtFW CIH (PESM).

5.0 ACTIVITY HAZARD ANALYSES

Activity Hazard Analyses (AHAs) are the focal point for safe conduct of work on a project. An AHA has been developed for each planned work activity to identify the sequence of work, specific hazards anticipated, and the control measures to be implemented to minimize or eliminate each hazard. The AHAs will be covered during the preparatory phase meetings for all definable project tasks and will be used to augment daily safety meetings intended to heighten safety and hazard awareness on the job.

AHAs for this project are included in Attachment 2. These AHAs, having been prepared prior to the initiation of work activities, consider the anticipated hazards. Additional AHAs may be necessary to address tasks that were not identified at the time this SHSP was written. During the site characterization work, if any changes to the existing AHAs are necessary due to changing site conditions or requirements, the SHSS will ensure that the affected AHAs are updated and that workers review the amended AHAs. The SHSS will forward any new or modified AHAs to the PESM for review.

6.0 PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment (PPE) will be selected and used based upon the existing and potential hazards anticipated. Various levels of PPE will be provided to workers at the site depending on the specific work tasks to be performed. The selection of PPE requires an evaluation of chemical contaminants, concentrations of these chemical contaminants, and physical hazards that may be encountered.

The initially established PPE and action levels for the characterization activities presume that the contaminants are non-volatile and that techniques used will not generate aerosols or dust. A PPE matrix is included as Table 6-1 to specify the minimum PPE requirements for each task, as known at the start of the project. As additional testing, monitoring, and background information become available, the SHSS may adjust the action levels and PPE accordingly. Any changes to PPE require approval by the PESM. The decision to upgrade or downgrade the level of protection required in the field will be communicated as appropriate to all site personnel. The decision and justification for the change in level of protection will be recorded in the health and safety logbook.

7.0 AIR MONITORING AND RADIATION SCREENING

Air monitoring will not be necessary for daily field activities, unless new contaminants or a substantial increase in existing contaminants are suspected to be encountered. If dust levels are visible, air monitoring for dust will be performed. Personal air sampling is also not planned at this time; however, as the work proceeds and if procedures are modified or other contaminants are encountered, personal air sampling may be required. The SHSS will contact the PESM if conditions change from those currently anticipated.

Site activities that involve ground disturbances, including drilling and sampling activities, will require monitoring for radium-containing devices. Radiological screening is discussed in detail in the RCP (TtFW, 2004b).

8.0 SITE CONTROL

To minimize the transfer of potentially hazardous substances from the site, contamination control procedures will be employed. The establishment of regulated areas and designated site work zones will be one method of contamination control. Site control through access control points will reduce the possibility of:

- Personnel exposure to site contaminants.
- Contaminant translocation by personnel or equipment from the site.

Methods that will be used to facilitate site access control include:

- Scheduling operations to minimize numbers of personnel at the site.
- Establishing site work zones around each work site location.
- Establishing control points to regulate access to and egress from work zones.
- Implementing appropriate decontamination procedures.

The areas surrounding the proposed soil boring and sampling locations will be controlled by barricades, cones, and caution tape. The cordoned areas will be considered exclusion zones. On the boat or barge, the area immediately in the vicinity of the sample collection will be the exclusion zone. On small boats, the entire boat will be an exclusion zone. Entries into these areas will require personnel to have the proper PPE and training. The Construction Manager and the SHSS will implement control measures as necessary.

8.1 SITE SECURITY

HPS has a Department of Defense police force. The San Francisco Redevelopment Agency provides guard services at the Innes Avenue entrance to HPS. Personnel entering HPS must have a badge and a parking permit. However, HPS has had significant scavenging and thefts. Project equipment will be stored in a fenced and secured area. The Metal Reef/Slag Project Manager may employ the use of a private security guard service to augment HPS security.

Workers should always assure that their vehicles are in good operating condition and that they have sufficient fuel. When re-entering any area for the day's work, the entire work area is to be reinspected by the SHSS and at least one other person to assure that the work area is unchanged from the previous day's work. Personnel will verify that their equipment has not been altered or vandalized. Inspections of equipment must be performed each day. If workers discover syringes, needles, drugs, unknown containers, and so forth, they will inform the SHSS so that the items can be safely removed. Workers will not attempt to remove these items on their own.

8.2 EQUIPMENT DECONTAMINATION

Heavy equipment, PPE, monitoring equipment, and sampling equipment may require decontamination. As equipment is moved from one work area to the next work area, the parts of the equipment that may have been contaminated, but not yet washed off, can be covered with plastic to facilitate movement of the equipment to the next work area without performing a full decontamination wash. However, it is essential that all gross contamination be removed from the equipment before moving the equipment out of a work zone. Pressure washing of equipment contaminated with PCBs should be avoided to prevent aerosolization of the PCBs. Other contaminants may be scraped or brushed off.

All PPE waste generated will be bagged, labeled, and stored for off-site disposal or incorporation into other waste materials. In no case will storage exceed 90 days from the start date of accumulation of the waste.

8.3 PERSONNEL DECONTAMINATION

At a minimum, site workers will be provided with adequate restroom and hand washing facilities and will be required to wash exposed areas of the skin (that is, hands and face) upon exiting potentially contaminated areas. Smoking, eating, or drinking will not be allowed in active work areas.

In case of an emergency, gross decontamination procedures will be implemented and the person will be transported to the nearest medical facility immediately at the direction of the SHSS according to the Emergency Response Plan (see Section 12.0). The medical facility will be informed that the injured person is on the way, and has not been fully decontaminated. The medical facilities will be notified of the potential chemicals present and of the exposure-prevention measures that can be used while treating the victim.

9.0 MEDICAL SURVEILLANCE PROCEDURES

The Base-Wide Plan (TtFW, 2004a) describes medical surveillance procedures for all projects at HPS. No additional medical surveillance procures are anticipated for this particular project.

10.0 SAFETY CONSIDERATIONS

For general safety considerations, refer to the Base-Wide Plan (TtFW, 2004a). Additional guidelines that should be adhered to include the following:

- Telephone communications will be confirmed as functioning.
- Project personnel will work in sight of each other. If it is necessary for workers to work out of sight of each other, the buddy system will be used and each team will have a means of communicating via telephone (either each team has a telephone or at least one team has a telephone and the remaining teams can communicate by way of radio with the team that has the telephone).
- Work will only be performed during daylight hours (half an hour after sunrise to half an hour before sunset). When working on vessels, work will be planned so that activities are completed and all personnel return to shore during daylight hours.
- Workers will park only in designated areas and will be reminded to follow traffic rules and regulations within and around the project site. In particular, workers are reminded to wear seatbelts in all vehicles at all times.
- Workers will be reminded to follow applicable USCG rules and regulations during boating operations. In particular, workers are reminded to wear life vests in all watercraft at all times.
- Underground Services Alert (800) 642-2444 will be called prior to digging into the ground.
- Housekeeping is important to maintain a safe workplace. As work is performed, the work area will be kept clean to avoid creating hazards that may cause injuries. Hazards associated with poor housekeeping usually involve slips, trips, or falls. In addition, workers should avoid generating dust when they clean up a work area.

11.0 DISPOSAL PROCEDURES

The Waste Management Plan, contained in Appendix C of the Work Plan (TtFW, 2004b), describes the handling of wastes from the project site and the management of all decontamination fluids, disposable clothing, and supplies that have come into contact with contaminated materials. Disposable PPE will be treated as contaminated waste and disposed of properly. Contaminated clothing will be placed in a drum lined with polyethylene. Wastewater generated on site will be stored until it is ready for testing and disposal. Temporary waste storage areas will be set up adjacent to each work area during the workday. This waste will then be moved to a main storage area until ready for disposal, if required by environmental personnel. All waste containers will be properly labeled and stored in accordance with regulatory requirements. Container contents will be sampled by trained sample technicians and sent to a laboratory to determine the appropriate disposal methods. TtFW will arrange for the proper disposal of all decontamination fluids, contaminated debris, soil, and other wastes per contract requirements. In no case will waste accumulation be allowed to exceed 90 days from the date that the accumulation began. Waste disposal procedures will be managed by firms that have been pre-approved by an internal review process and by the DON.

The Metal Reef/Slag Project Manager, the Construction Manager, the SHSS, and other personnel assigned to the project must receive waste management and Department of Transportation training prior to performing tasks associated with waste management.

Any radioactive material that is discovered and removed will be managed separately, as specified in the RCP (TtFW, 2004b).

12.0 EMERGENCY RESPONSE PLAN

Refer to the Base-Wide Plan (TtFW, 2004a) for emergency response activities. Personnel shall maintain verbal communication with each other, and telephone services must be available at all times during the project. Figure 12-1 shows the routes to the nearest hospital and clinic from the site. The locations of the evacuation assembly points for metal debris reef and metal slag areas are shown in Figure 12-2. Table 12-1 consists of a list of emergency contacts and telephone numbers. Figure 12-1, Figure 12-2, and Table 12-1 must be placed on the dashboard of each site vehicle and posted in the project area.

Emergency contact names and phone numbers will be posted at every work area and in the project offices. A map showing egress routes, evacuation assembly areas, and the route to the clinic and the hospital will also be posted. The contact names, phone numbers (Table 12-1), and maps (Figures 12-1 and 12-2) will be placed on the dashboard of every vehicle.

The following emergency equipment, at a minimum, will be brought onto the site or will be stationed near each onshore work area:

- Fire extinguisher, minimum one 20-pound dry chemical ABC type
- Industrial first aid kit
- Portable eye wash, capable of supplying 15 minutes of water and protected from direct sunlight
- Air horn
- Spill control material consisting of absorbent pillows or absorbent material and shovels, plastic sheeting, and 55-gallon drum(s)
- Communication (cell phone or radio)

The following emergency equipment, at a minimum, will be brought onto each vessel used for offshore work:

- Life vests (Personal Flotation Devices, USCG approved, minimum one per person)
- A minimum of one "throwable" USCG Type IV, rescue life ring (life saver)
- Fire extinguisher, minimum one 10-pound dry chemical ABC type
- Industrial first aid kit
- Portable eye wash, capable of supplying 15 minutes of water and protected from direct sunlight
- Signal smoke and flares

- Air horn
- Spill control material consisting of absorbent booms, absorbent materials, and plastic bags
- Communication (cell phone or radio)

13.0 TRAINING

Personnel will be required to receive training on this SHSP, the AHAs, and the Base-Wide Plan (TtFW, 2004a). Included in this training will be a general site orientation, the location of all emergency equipment, the location of the emergency assembly points, and the routes to the nearest clinic and hospital. This training will also allow field workers to clarify anything they do not understand and to reinforce their responsibilities regarding health and safety for their particular activity. Workers will receive radiation awareness training. Specific work procedures for in, around, or on water will be performed. Workers working from ships, boats, barges, or any other type of watercraft will receive training on boating operations and all aspects of safety concerning work from watercraft, including the use of emergency equipment. Additional training, if required for completion of field tasks during the site work, will be identified and provided for personnel as the work progresses.

Upon completion of this training and review, all project personnel will acknowledge this training by signing the SHSP review form. A daily safety meeting form will be used to document training in the AHAs as they are reviewed and discussed with the employees.

14.0 LOGS, REPORTS, AND RECORDKEEPING

Logs, reporting, and recordkeeping requirements are included in the Base-Wide Plan (TtFW, 2004a). Forms to be used during this project are included in Attachment 3.

15.0 REFERENCES

- Department of the Navy, Southwest Division Naval Facilities Engineering Command (SWDIV). 2001. *Final Basewide Radiological Removal Action, Action Memorandum, Hunters Point Shipyard, San Francisco, California*. November 19.
- Leung, H.W. and D.J. Paustenbach. 1988. Application of pharmacokinetics to derive biological exposure indexes from threshold limit values. *American Industrial Hygiene Association Journal*. 49(9). 445-450.
- Tetra Tech EMI, Incorporated (TtEMI), Uribe and Associates (U&A), and Levine-Fricke Recon. 1997. *Draft Final Parcel E Remedial Investigation Report, Hunters Point Shipyard, San Francisco, California*. October 27.
- TtEMI. 2002. *Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan) for Parcel E Standard Data Gaps Investigation, Hunters Point Shipyard, San Francisco, California*, August 22.
- Tetra Tech FW, Inc. (TtFW). *TtFW Corporate Health and Safety Program Manual*. Most recent.
- TtFW. *TtFW Project Rules Handbook*. Most recent.
- TtFW. 2004a. *Final Base-Wide Health and Safety Plan*. April 2004.
- TtFW. 2004b. *Final Characterization Work Plan*. Metal Debris Reef and Metal Slag Areas, Parcel E, Hunters Point Shipyard, San Francisco, California. June 18.

Note:

Where no date is given in the references above, it is assumed that the reference used will be the most recent publication.

TABLES

TABLE 4-1
CHEMICAL HAZARDS ASSESSMENT

Chemical Name	PEL/TLV	Routes of Exposure	Symptoms of Exposure	Target Organs
Antimony	PEL - 0.5 mg/m ³ TLV - 0.5 mg/m ³	Inhalation, ingestion, skin contact	Acute: Inhalation can cause sore throat, shortness of breath metallic taste, vomiting, nausea, weight loss. Skin contact is irritating especially if skin is moist. Ingestion causes irritation of intestinal tract, vomiting, bloody stools, slow pulse and low blood pressure, coma, convulsions, and death. Chronic: Inflammation of respiratory tract. Skin papules and pustules especially in moist areas.	Eyes, skin, respiratory and cardiovascular system.
Arsenic, inorganic	PEL - 0.01 mg/m ³ TLV - 0.01 mg/m ³	Inhalation, ingestion, skin contact	Human carcinogen. Acute: Nasal irritation, perforation of septum, chest pain, hoarseness, eyelid edema, pharyngitis, inflammation of mouth. Metallic or garlic taste, nausea, vomiting, diarrhea, abdominal pain, heartbeat irregularities. Acute poisoning may cause acute hemolysis of red blood cells. Chronic: Weight loss, hair loss, nausea, diarrhea, alternating with constipation, thickening of skin on palms of hands and soles of feet, skin eruptions, inflammation of nerves, leukemia, bone marrow depression, aplastic anemia.	Liver, kidneys, skin, lungs, lymphatic system.

TABLE 4-1
CHEMICAL HAZARDS ASSESSMENT

Chemical Name	PEL/TLV	Routes of Exposure	Symptoms of Exposure	Target Organs
Beryllium	PEL - 0.002 mg/m ³ TLV - 0.002 mg/m ³ STEL(30-min) - 0.005 mg/m ³ Ceiling - 0.025 mg/m ³	Inhalation, ingestion, skin contact	<p>Carcinogen.</p> <p>Highly toxic by inhalation of fume or dust, may cause death.</p> <p>Acute: Symptoms may be delayed up to 72 hours after exposure. Pneumonitis, nasal congestion, nonproductive coughing, and pulmonary edema. Brain hemorrhage, liver inflammation and spleen hemorrhaging.</p> <p>Chronic: Symptoms may be delayed up to 15 years. Granuloma formation in lungs, heart enlargement and failure, liver and spleen enlargement, malignant tumors.</p>	Lungs, mucous membranes, eyes and skin.
Cadmium	PEL - 0.005 mg/m ³ TLV - 0.01 mg/m ³ TLV - 0.002 mg/m ³ (respirable fraction)	Inhalation, ingestion, skin contact	<p>Human carcinogen.</p> <p>Acute: Metallic taste in mouth, nausea, vomiting, chills, weakness, leg pain, diarrhea, cough, headache, shortness of breath, chest pains, kidney damage, restlessness and irritability, pneumonitis, bronchitis, pulmonary edema, and eye and skin irritation. Ingestion causes severe nausea, salivation, choking, vomiting, diarrhea, abdominal pain, headache, muscular cramps, and vertigo.</p> <p>Chronic: Chronic bronchitis and rhinitis, loss of smell, gastrointestinal symptoms, pulmonary fibrosis, emphysema, kidney stones, changes in bone, yellow discoloration of teeth.</p>	Kidneys, respiratory and gastrointestinal tracts.

TABLE 4-1
CHEMICAL HAZARDS ASSESSMENT

Chemical Name	PEL/TLV	Routes of Exposure	Symptoms of Exposure	Target Organs
Cobalt, inorganic compounds	PEL - 0.1 mg/m ³ TLV - 0.02 mg/m ³	Inhalation, ingestion, skin contact	Possible Carcinogen Acute: Contact dermatitis, breathing difficulties. Chronic: Allergic asthma, restricted pulmonary functions, and intestinal fibrosis.	Respiratory system, skin, bladder, kidneys, eyes.
Copper	PEL - 1.0 mg/m ³ , dust TLV - 1.0 mg/m ³ , dust No established PEL or TLV for copper compounds	Inhalation, ingestion	Acute: Copper fumes and dust- allergic reactions, metallic taste, nausea, general weakness, exhaustion. Greenish-black skin, irritation of skin, nose, mouth, respiratory tract. Ingestion causes vomiting, nausea, abdominal pain, and diarrhea. Chronic: Mild dermatitis, degeneration of mucous membranes. Chronic respiratory disease of mucous membranes. Chronic respiratory disease.	Respiratory system, skin, eyes, liver, kidneys.
Dioxins	Maximum manufacturing specifications – 0.1 ppm Recommended preliminary occupational exposure limit based on AIHA Journal (Leung and Paustenbach.1988): 0.000002 mg/m ³	Inhalation, ingestion, skin contact	Possible Carcinogen Acute: Shortness of breath, headache, fatigue, severe muscle pains, weakness, and digestive disturbance. Chemical burns, chloracne, photosensitivity, nausea, and vomiting. Chronic: Lack of energy, loss of sex drive, personality and mood changes, numbness, weakness and pain in the legs, liver damage, chloracne, and elevated blood lipids.	Skin, liver, respiratory system.

CHEMICAL HAZARDS ASSESSMENT

Chemical Name	PEL/TLV	Routes of Exposure	Symptoms of Exposure	Target Organs
Lead	PEL - 0.05 mg/m ³ TLV - 0.05 mg/m ³ AL - 0.03 mg/m ³	Inhalation, ingestion, skin contact	Animal carcinogen. Acute: Seizures, coma, death (very high doses). Chronic: Appetite loss, nausea, metallic taste, constipation, anxiety, weakness, insomnia, muscle and joint pain, irritability, headache, numbness, kidney damage.	Systemic poisoning: nervous system, kidneys, reproductive system, blood, gastrointestinal system
Manganese	PEL - none STEL 5.0 mg/m ³ TLV - 0.2 mg/m ³	Inhalation, ingestion, skin contact	Acute: Metal fume fever, skin and eye irritant. Chronic: CNS damage, headache, sleepiness, personality changes, irritability, inappropriate laughing or crying, hallucinations, euphoria, excess salivation, trembling extremities and head, and impaired walking.	CNS, respiratory system, kidneys, blood.
Mercury, inorganic compounds	PEL - Ceiling - 0.1 mg/m ³ TLV - 0.025 mg/m ³	Inhalation, ingestion, skin contact	Acute: Respiratory damage, wakefulness, muscle weakness, loss of appetite, headache, diarrhea, liver changes, cough, bronchitis, pneumonitis, and acrodynia. Chronic: CNS damage, weakness, fatigue, nausea, weight loss, gastrointestinal disturbances, tremors, memory loss, insomnia, and depression.	CNS, eyes, skin, respiratory system, liver, kidneys.
Molybdenum	PEL - none TLV - 10 mg/m ³ insoluble 3 mg/m ³ respirable 0.5 mg/m ³ soluble	Inhalation, ingestion, skin contact	Acute: Mild, transient irritation of eyes, nose, and throat. Elevated serum uric acid levels (potential gout). Chronic: None reported.	None reported.

TABLE 4-1
CHEMICAL HAZARDS ASSESSMENT

Chemical Name	PEL/TLV	Routes of Exposure	Symptoms of Exposure	Target Organs
Nickel, elemental	PEL - 1.0 mg/m ³ TLV - 1.5 mg/m ³ inhalation	Inhalation, ingestion, skin contact	Human carcinogen. Acute: Nickel fume causes respiratory tract irritation, metal fume fever, asthma, lung inflammation, eye irritation, nausea, vomiting, and abdominal pain. Dermal contact causes nickel "itch." Sensitization with eczema.	Skin, lungs, nasal cavities.
Nickel, insoluble compounds	PEL 1.0 mg/m ³ TLV - 0.2 mg/m ³ insoluble, inhalation			
Nickel, soluble compounds	0.1mg/m ³ soluble, inhalation		Chronic: Nickel sensitization, eczema, hardened and leathery skin, Chronic pulmonary irritation, chronic thickening of mucous membranes, impairment or loss of smell, perforation of nasal septum. Chronic dust exposure can cause cancer of sinuses, larynx, and lungs.	
Pesticides - as representative pesticides, DDT and malathion were selected since agricultural uses were likely				
DDT (chlorinated pesticide)	PEL - 1.0 mg/m ³ TLV - 1.0 mg/m ³	Inhalation, ingestion, skin contact	Suspected human carcinogen. Acute: Ingestion of large amounts can cause vomiting, malaise, headache, sore throat, apprehension, ataxia, and confusion. Chronic: No confirmed chronic effects.	CNS, liver, skin, peripheral nervous system.

CHEMICAL HAZARDS ASSESSMENT

Chemical Name	PEL/TLV	Routes of Exposure	Symptoms of Exposure	Target Organs
Malathion (organophosphate pesticide)	PEL - 15.0 mg/m ³ total dust TLV - 1.0 mg/m ³ inhalation	Inhalation, ingestion, skin contact	Acute: Weakness, general twitching and paralysis, dizziness, confusion, staggering, slurred speech, sweating, irregular or slow heart beat, convulsions, stop breathing, coma. Loss of appetite, and abdominal cramps. Chronic: Increased susceptibility to organophosphates.	Respiratory system, liver, blood cholinesterase, gastrointestinal tract, CNS, and CVS.
Polychlorinated biphenyls	PEL - 0.05 mg/m ³ TLV - 0.05 mg/m ³	Inhalation, ingestion, skin contact	Acute: Irritation to eyes, skin, nose, throat, and respiratory tract. Intense acute exposure may cause damage to eyes, liver, or lungs. Systemic effects include nausea, vomiting, high blood pressure, fatigue, weight loss, jaundice, edema, and abdominal pain. Neurological impairment is possible. Chronic: Chloracne, neurological symptoms, and liver enlargement. Cancer, primarily of the liver.	Skin, liver, eyes, mucous membranes and respiratory tract.
Silver, soluble compounds	PEL - 0.01 mg/m ³ TLV - 0.01 mg/m ³	Inhalation, ingestion, skin contact	Acute: Silver fumes caused lung damage and pulmonary edema. Some compounds in contact with skin are corrosive and cause dark pigmentation of skin (photosensitization). Chronic: Deposition of silver in skin tissues causes argyria - a condition causing blue-grey pigmentation.	Skin, eyes, mucous membranes.

TABLE 4-1
CHEMICAL HAZARDS ASSESSMENT

Chemical Name	PEL/TLV	Routes of Exposure	Symptoms of Exposure	Target Organs
Vanadium	PEL - 0.05mg/m ³ TLV - 0.05 mg/m ³ as vanadium pentoxide	Inhalation, ingestion, skin contact	<p>Elemental vanadium is relatively non-toxic.</p> <p>Acute: Skin - Eczema-like reaction with intense itching. Green discoloration of hands and groin area. Eyes - Severe irritation with burning and tearing. Airway - Nasal congestion, throat irritation, dry mouth, green tongue, metallic taste, coughing chest pain, pulmonary edema. Cardiovascular - Constriction of blood supply. CNS - Headaches gastrointestinal - Diarrhea, black stool and cramping.</p> <p>Chronic: Lung effects last 2 weeks after exposure. Skin and tongue discoloration may occur gradually.</p>	Respiratory system, skin, eyes.
Zinc	PEL - 5.0 mg/m ³ TLV - 2.0 mg/m ³ respirable as zinc oxide	Inhalation, ingestion, skin contact	<p>Elemental zinc relatively non-toxic. Compounds have various effects.</p> <p>Acute: metal fume fever. Gastroenteric irritation. Irritation to skin.</p> <p>Chronic: Compounds of zinc may have other residual effects.</p>	Respiratory system.

TABLE 4-1
CHEMICAL HAZARDS ASSESSMENT

Notes:

AIHA – American Industrial Hygienist Association
AL – action level
CNS – central nervous system
CVS – cardiovascular system
DDT - dichlorodiphenyltrichloroethane
mg/m³ – milligrams per cubic meter
PEL – permissible exposure level
ppm – parts per million
STEL – short-term exposure limit
TLV – threshold limit value

TABLE 6-1
PERSONAL PROTECTIVE EQUIPMENT

Task	EPA Level	Respiratory Protection	Head	Hand	Clothing	Boots	Face	Eye	Hearing	Additional
Site setup, surveys (non-intrusive)	D	None required, unless dust exceeds action level.	Hard hat.	Leather work gloves, as needed.	Work uniform or Tyvek® coveralls to keep clean	Steel-toe, leather.	N/A	Safety glasses.	Protection when noise levels exceed 84 dBA.	Fall protection for work above 6-foot level. Reflective safety vests.
Collecting samples, vibracore, or hollow stem auger	Modified C	None required, unless dust exceeds action level.	Hard hat.	Leather work gloves, as needed. Nitrile gloves when handling liquids.	Work uniform or Tyvek® coveralls to keep clean, rainsuits for work near water as needed.	Steel-toe, leather, slip resistant soles or PVC steel to boots	N/A	Safety glasses.	Protection when noise levels exceed 84 dBA.	Fall protection for work above 6-foot level. Reflective safety vests. Personal flotation devices (life vests) when performing work on or near water.

Notes:

dBA – decibels, A-scale

EPA – U.S. Environmental Protection Agency

N/A – not applicable

TABLE 12-1

EMERGENCY INFORMATION

<p align="center">REPORT ALL FIRES, SERIOUS INJURY, OR UNCONTROLLED SPILLS IMMEDIATELY: 911</p>
--

Clinic:	<p>Concentra Medical Center 415-648-9501 Occupational Health Clinic 728 20th Street San Francisco, CA 94107</p> <p>Hours of Operation: 7:30 A.M. - 5:00 P.M. (Mon. – Fri)</p> <p>From the TtFW offices at HPS, use Nimitz to go toward the main gate. (The Innes Avenue gate is the only open gate to HPS). Once on Innes, continue northwest on Innes, bear right on to Hunters Point Boulevard. Continue on Hunters Point Boulevard, which becomes Evans. Continue on Evans and turn right at 3rd Street. Continue on 3rd Street past Cesar Chavez until 20th Street. Turn left, clinic is on the right.</p>		
Hospital:	<p>San Francisco General Hospital (415) 206-8000 1001 Potrero Avenue San Francisco, CA 94110</p> <p>From the TtFW offices at HPS, use Nimitz to go toward the main gate. (The Innes Avenue gate is the only open gate to HPS). Once on Innes, continue northwest on Innes, bear right on to Hunters Point Boulevard. Continue on Hunters Point Boulevard, which becomes Evans. Continue on Evans and turn right at 3rd Street. Continue to Cesar Chavez. Turn left onto Cesar Chavez. Continue west on under the 280 Freeway and continue under the 101 Freeway, turn right on Potrero. Continue on Potrero, hospital will be on the right on 23rd Street.</p>		
Fire/Police/EMS:	<p>911 There is a federal fire department and Department of Defense Police on HPS, but they should be contacted through the 911 number.</p> <p><i>911 calls from a cell phone do not go directly to HPS emergency services, but through the California State Highway Patrol.</i></p>		
TtFW Contacts:	<p>Project Manager Glenn Starr (619) 471-3517 cell: (619) 602-6483</p>	<p>Project PESM (CIH) Roger Margotto (619) 471-3503 pager: (714) 810-3742</p>	<p>Project SHSS Richard Quinn. CSP (415) 671-1990 cell: (650) 450-1969</p>
RPM:	<p>Jose Payne (619) 532-0952</p>		
ROICC:	<p>Peter Stroganoff Project Engineer (510) 749-5941</p>	<p>Andy Uehisa Construction Management Technician (510) 749-5946</p>	

TABLE 12-1

EMERGENCY INFORMATION

CSO:	Michael Mentink (415) 743-4729 (415) 559-9851 (cell) Environmental Compliance Manager
Poison Control Center:	California Poison Control System, Central Office Emergency Phone: (800) 876-4766 [All of CA]
CHEMTREC:	(800) 424-9300
National Response Center:	(800) 424-8802
RCRA Hotline:	(800) 424-9346

Notes:

CHEMTREC	Chemical Transportation Emergency Center	PESM	Project Environmental and Safety Manager
CIH	Certified Industrial Hygienist	RCRA	Resource Conservation and Recovery Act
CSO	Caretaker Site Office	ROICC	Resident Officer in Charge of Construction
CSP	Certified Safety Professional	RPM	Remedial Project Manager
EMS	Emergency Medical Services	SHSS	Site Health and Safety Specialist
HPS	Hunters Point Shipyard	TtFW	Tetra Tech FW, Inc.

FIGURES

DRAWN BY: KLD	CHECKED BY: RM	APPROVED BY: LR	DCN: FWSO-RAC-04-2236	DRAWING NO: 04223611.DWG
DATE: 06/29/04	REV: REVISION 0		CTO: 0072	

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 PLOT/UPDATE: JUN 25 2004 14:20:23

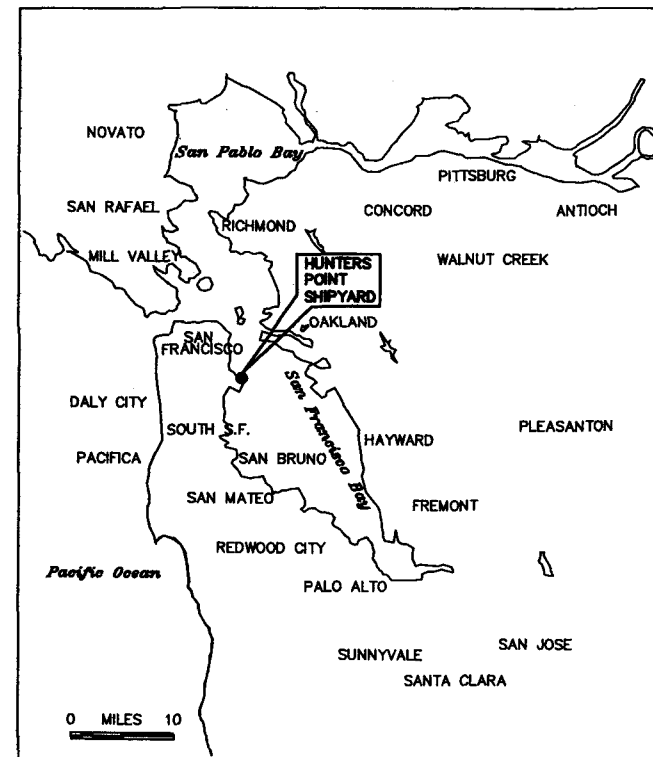
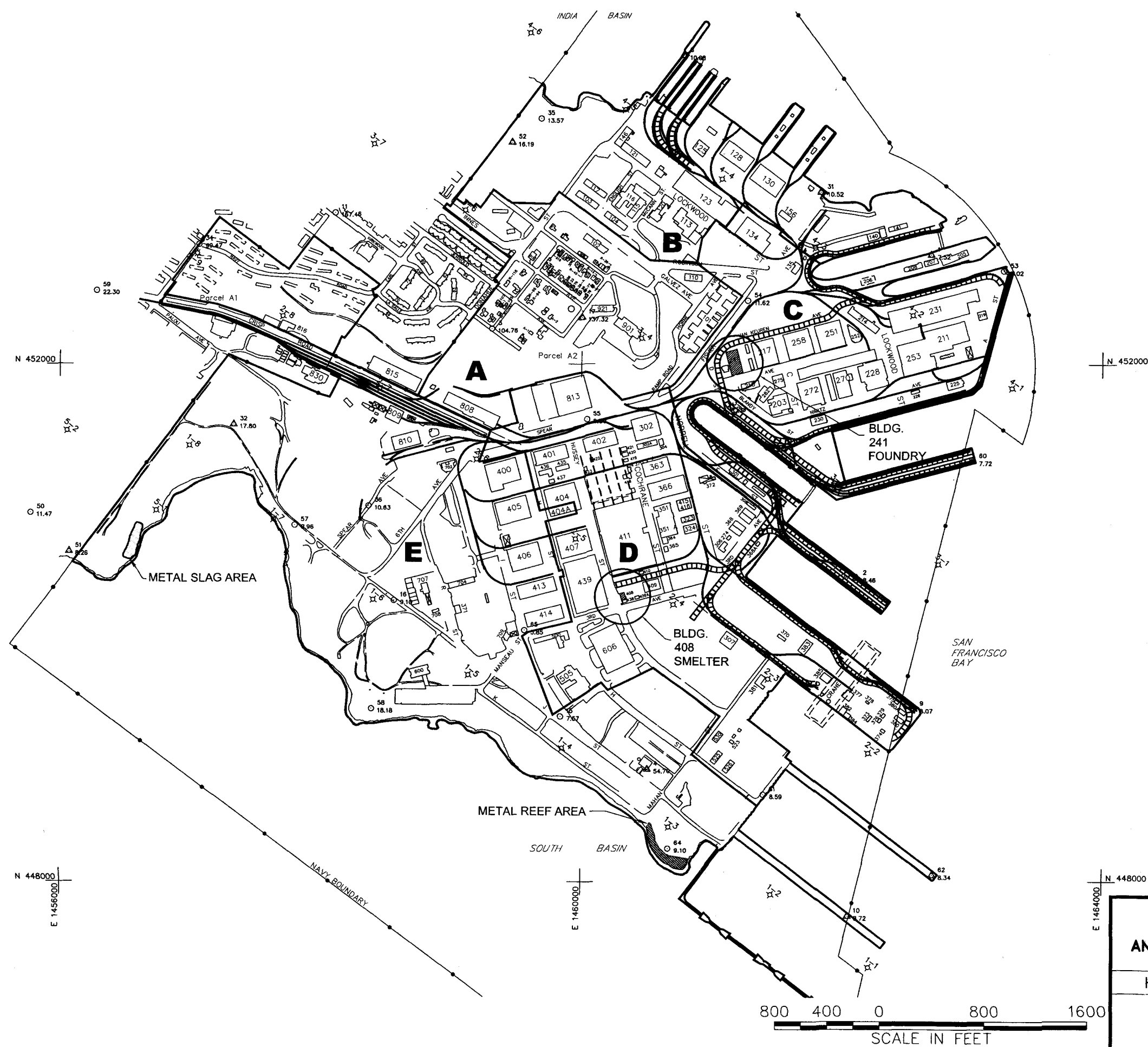


Figure 1-1
**HUNTERS POINT SHIPYARD
 AND THE METAL REEF AND METAL SLAG AREAS
 LOCATION MAP**
 HUNTERS POINT SHIPYARD, SAN FRANCISCO

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DATE: 06/29/04	REV: REVISION 0	CTO: 0072		04223621.DWG

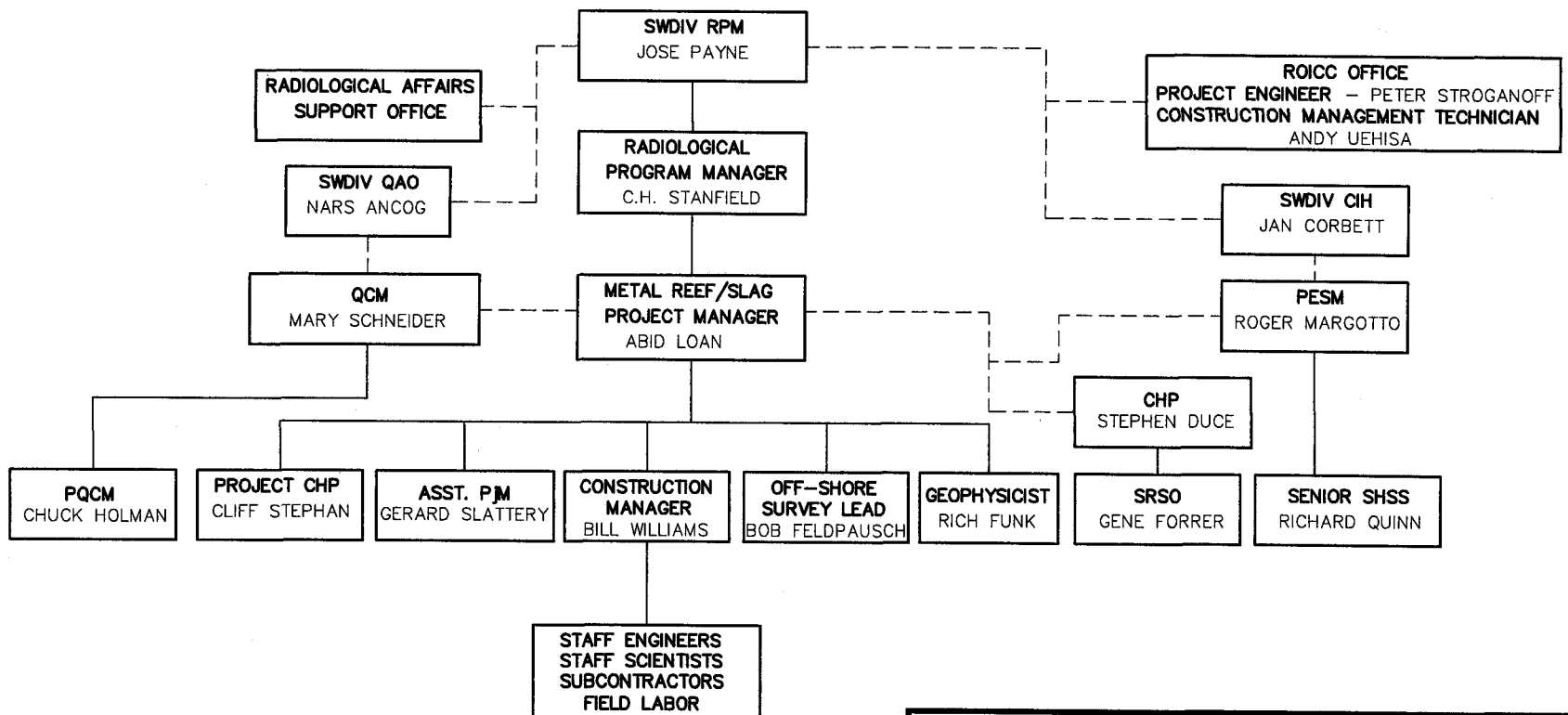


Figure 2-1
 PROJECT ORGANIZATION CHART

HUNTERS POINT SHIPYARD, SAN FRANCISCO, CA.



TETRA TECH FW, INC.



LEGEND

- TtFW SITE OFFICES
- ★ CONCENTRA MEDICAL CENTER OCCUPATIONAL HEALTH CLINIC
- ✚ SAN FRANCISCO GENERAL HOSPITAL
- ROUTE TO CLINIC
- ROUTE TO HOSPITAL

Concentra Medical Center 415-648-9501
 Occupational Health Clinic
 728 20th Street
 San Francisco, CA 94107

Hours of Operation: 7:30 A.M. - 5:00 P.M. (Mon. - Fri)

From the TtFW offices at HPS, use Nimitz to go toward the main gate. (The Innes Avenue gate is the only open gate to HPS). Once on Innes, continue northwest on Innes, bear right on to Hunters Point Boulevard. Continue on Hunters Point Boulevard which becomes Evans. Continue on Evans and turn right at 3rd Street. Continue on 3rd Street past Cesar Chavez until 20th Street. Turn left, clinics are on right.

San Francisco General Hospital (415) 206-8000
 1001 Potrero Avenue
 San Francisco, CA 94110

From the TtFW offices at HPS, use Nimitz to go toward the main gate. (The Innes Avenue gate is the only open gate to HPS). Once on Innes, continue northwest on Innes, bear right on to Hunters Point Boulevard. Continue on Hunters Point Boulevard which becomes Evans. Continue on Evans and turn right at 3rd Street. Continue to Cesar Chavez. Turn left onto Cesar Chavez. Continue west on under the 280 Freeway and continue under the 101 Freeway, turn right on Potrero. Continue on Potrero. Hospital will be on the right on 23rd Street.



NOT TO SCALE

Figure 12-1
 ROUTE TO CLINIC AND HOSPITAL

HUNTERS POINT SHIPYARD, SAN FRANCISCO



TETRA TECH FW, INC.

DRAWING NO:
042236122.DWG

DCN: FWSD-RAC-04-2236

CTO: 0072

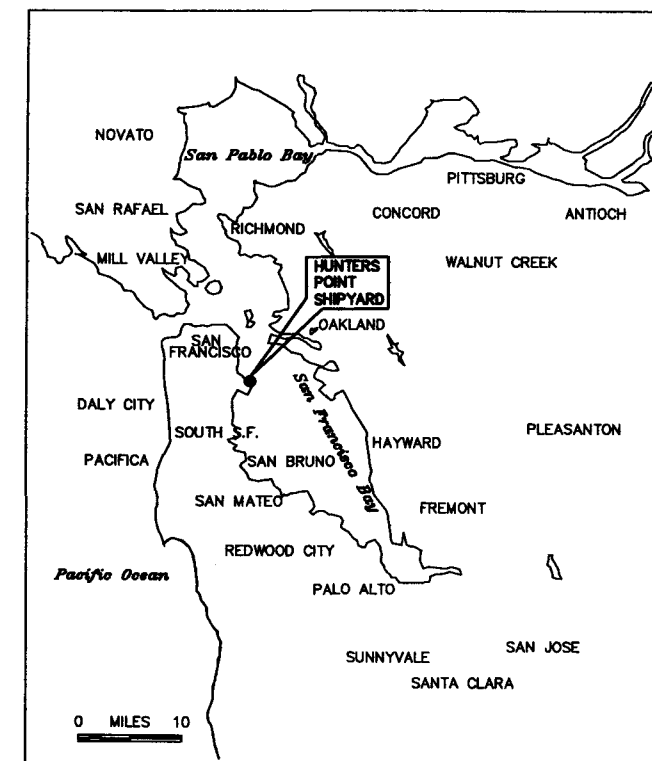
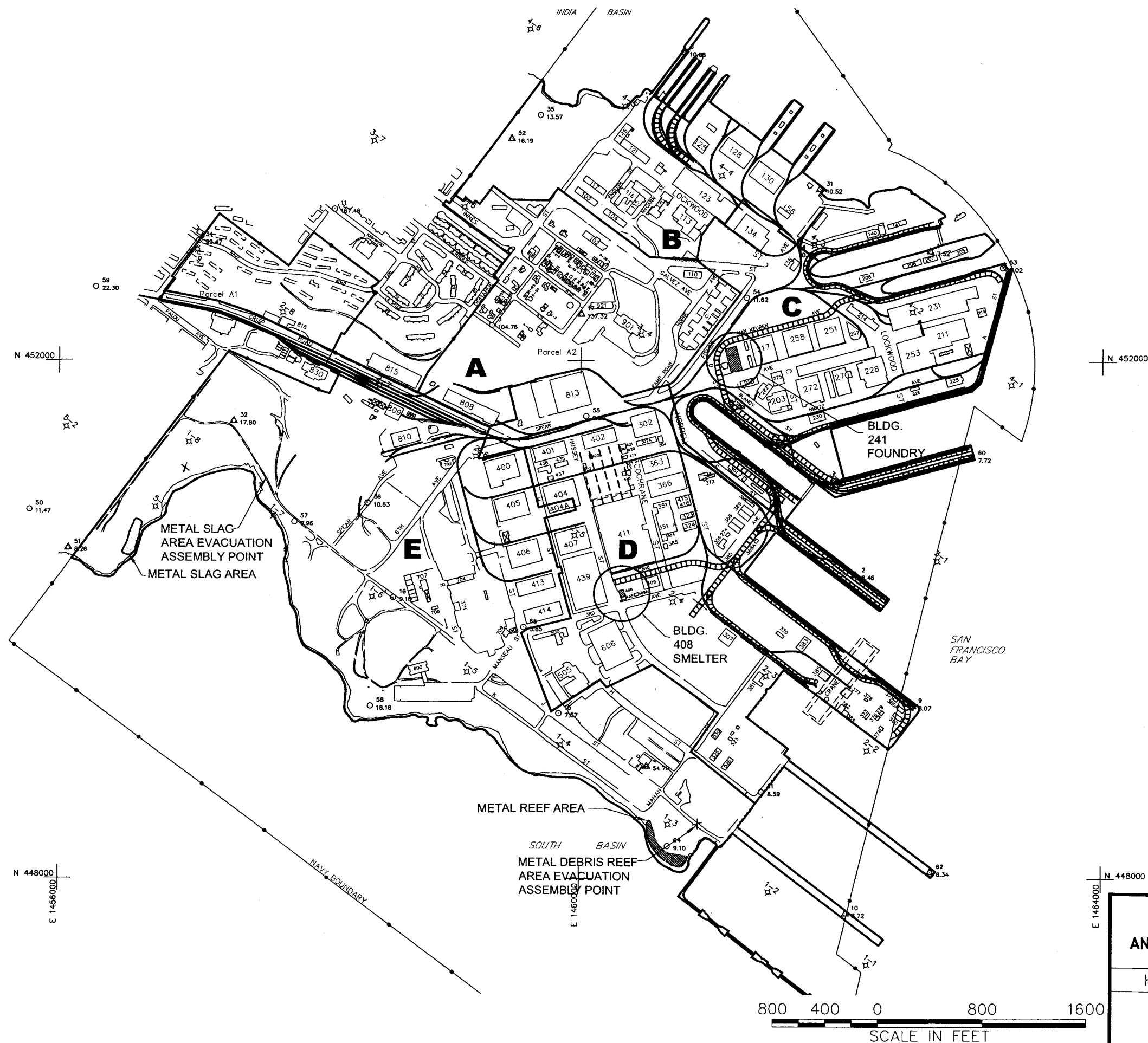
APPROVED BY: GS

REV: REVISION 0

DRAWN BY: KLD

DATE: 06/29/04

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PLOT/UPDATE: JUN 25 2004 13:59:13



KEY MAP

Figure 12-2
HUNTERS POINT SHIPYARD
AND THE METAL REEF AND METAL SLAG AREAS
ASSEMBLY POINTS
HUNTERS POINT SHIPYARD, SAN FRANCISCO



TETRA TECH FW, INC.

ATTACHMENT 1
MATERIAL SAFETY DATA SHEETS

**Section 1. Material Identification**

Antimony Trioxide (Sb_2O_3) Description: Derived by heating antimony ore and recondensing the fumes, adding ammonium hydroxide to antimony chloride, or direct extraction from low-grade ores. Used in fire retarding of textiles, paper, and plastics (chiefly PVC); paint pigments; high stability specialty lubricants; phosphors; as a ceramic opacifier; catalyst; mordant; glass decolorizer; and chemical intermediate.

Other Designations: CAS No. 1309-64-4, antimonious oxide, antimony peroxide, antimony sesquioxide, antimony white, Antox, C.I. Pigment White II, Dechlorane-A-O, diantimony trioxide, Exitelite, flowers of antimony, Senarmontite, Valentinite, White Star.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*⁽⁷³⁾ for a suppliers list.

		<i>powder</i>
R	1	HMIS
I	3	H 2*
S	2	F 1
K	2	R 0



Genium

		<i>cubes</i>
R	1	HMIS
I	3	H 2*
S	2	F 0
K	0	R 0



* Chronic effects

PPE†
† Sec. 8

Cautions: Antimony trioxide is an eye, skin, and mucous membrane irritant and is considered a suspected human carcinogen. The powder form will ignite and burn in air when heated.

Section 2. Ingredients and Occupational Exposure Limits

Antimony trioxide, < 100%. Impurities include arsenic.

1992 OSHA PEL

Transitional & Final Rule Limits
8-hr TWA: 0.5 mg/m³ (as Sb)

1993-94 ACGIH TLV

TWA: 0.5 mg/m³ (handling and use, as Sb)

1992 Toxicity Data*

Rat, inhalation, TC_{Lo} : 4200 µg/m³ given intermittently for 52 weeks caused liver and lung tumors.

1990 IDLH Level

80 mg/m³ (as Sb)

1991 DFG (Germany) MAK

TWA: 0.5 mg/m³ (as Sb)

Rat, oral, LD_{50} : > 20 g/kg

Rat, inhalation, TC_{Lo} : 270 µg/m³ from 1 to 21 days of pregnancy caused post-implantation mortality or fetal death.

1992 NIOSH REL

TWA: 0.5 mg/m³ (as Sb)

Category III: Substances with systemic effects
Onset of effects; > 2 hr

Half life: > shift length (strongly cumulative)

Peak Exposure limit: 5 mg/m³, 30 min. average value, 1/shift

* See NIOSH, *RTECS* (CC5650000), for additional mutation, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 843.3 °F (1550 °C), *sublimes**

Melting Point: 346.1 °F (655 °C)

Vapor Pressure: 1 mm Hg at 574 °F (1065.2 °C)

pH: Amphoteric (can react as an acid or a base)

Molecular Weight: 291.5

Density: 5.2

Water Solubility: Insoluble; 0.000029 mole/1000 g water at 77 °F (25 °C).

Other Solubilities: Soluble in sulfuric, hydrochloric, and nitric acids; potassium hydroxide; warm tartaric acid; bitartrates; alkali hydroxides and sulfides.

Appearance and Odor: White, odorless, crystalline powder or cubes.

* Sublimes in high vacuum at 752 °F (400 °C)

Section 4. Fire and Explosion Data

Flash Point: None reported

Autoignition Temperature: None reported

LEL: None reported

UEL: None reported

Extinguishing Media: The powder ignites and burns when heated; the cubes don't. Use dry chemical, carbon dioxide, water, or regular foam.

Unusual Fire or Explosion Hazards: The more finely divided the powder, the more readily it burns.

Special Fire-fighting Procedures: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Do not release runoff from fire control methods to sewers or waterways; dike for proper disposal.

Section 5. Reactivity Data

Stability/Polymerization: Antimony trioxide is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Include chlorinated rubber (at 420.8 °F/216 °C), bromine trifluoride, acids, oxidizers, and halogenated agents.

Conditions to Avoid: Excessive dust generation, exposure to heat or ignition sources, and contact with incompatibles.

Hazardous Products of Decomposition: Thermal oxidative decomposition of antimony trioxide can produce toxic antimony fumes.

Section 6. Health Hazard Data

Carcinogenicity: The ACGIH, TLV-A2 (suspected human carcinogen for Sb_2O_3 production)⁽¹⁸³⁾ and DFG, MAK-A2 (unmistakably carcinogenic animals only, Sb_2O_3 handling and use)⁽¹⁸³⁾ list antimony trioxide as a carcinogen.

Summary of Risks: Antimony trioxide is irritating to the eyes, skin, and respiratory tract. Chronic exposure appears to be more of a threat than acute exposure and is evident by heart disease, "antimony measles", and possible carcinogenicity. Liver and kidney damage is seen in animals but it is not clear if the same damage could occur in humans. Due to its insolubility in water, antimony trioxide is less toxic than soluble antimony salts. In addition, it is three times less toxic than the metal.

Medical Conditions Aggravated by Long-Term Exposure: Skin, heart, and lung disorders.

Target Organs: Eyes, skin, and the respiratory and cardiovascular systems.

Primary Entry Routes: Inhalation, skin and eye contact, ingestion.

Continue on next page

Section 6. Health Hazard Data, continued

Acute Effects: Inhalation can cause sore throat, headache, chest pain, shortness of breath, metallic taste, nausea and vomiting, diarrhea, and weight loss. Skin contact is irritating. Eye contact is irritating and can cause conjunctivitis. Ingestion causes irritation of the gastrointestinal tract, vomiting, bloody stools, slow pulse and low blood pressure, shallow breathing, and possibly, coma and convulsions resulting in death.

Chronic Effects: Chronic inhalation can cause inflammation of the respiratory tract resembling simple pneumoconiosis and is shown by radiographic lung changes (studied individuals were exposed up to 10 X the TLV). Lung cancer is possible based on an English epidemiologic study but at present, Sb_2O_3 only has status as a suspected carcinogen. There is also evidence of chronic heart disease due to effects on the heart muscle. Repeated or prolonged skin contact may cause "antimony measles", consisting of itchy papules and pustules around the sweat and fat glands. This is particularly seen in moist areas (elbows, underarms, groin area, etc.). The condition appears to be more prevalent when temperatures are high.

FIRST AID

Eyes: Do not allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin: Quickly remove contaminated clothing. Rinse with flooding amounts of water to remove any loose material, then wash with soap and water. For reddened or blistered skin, consult a physician.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless otherwise advised, have that conscious and alert person drink 1 to 2 glasses of water, then induce vomiting.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Support respiratory and cardiovascular function. A urine test can be used to confirm exposure-1 mg/L is indicative of potentially harmful exposure. Chelators such as BAL and unithiol have been used in some countries.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off ignition sources. Cleanup personnel should protect against inhalation and skin/eye contact. Avoid dust generation; do not sweep. Carefully scoop spills into suitable containers for disposal. Damp mop any residue. Vacuuming (with an appropriate filter) may also be used. Prevent entry into sewers, drains, and waterways. Follow applicable OSHA regulations (29 CFR 1910.120).

Environmental Transport: Antimony trioxide is not expected to volatilize from water because of its low vapor pressure.

Ecotoxicity Values: *Lepomis macrochirus* (bluegill sunfish), $LD_{50} = > 530$ mg/L/96 hr; *Pimephales promelas* (fathead minnow), $LD_{50} = > 833$ mg/L/96 hr.

Disposal: Consider returning large amounts to a smelter for reprocessing. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

RCRA Hazardous Waste (40 CFR 261.33): Not listed

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg) [* per CWA, Sec. 311 (b)(4)]

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

SARA Toxic Chemical (40 CFR 372.65): Not listed

OSHA Designations

Listed (as Sb) as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Consider the NIOSH respirator recommendations for antimony dust because there are no specific recommendations for antimony trioxide. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. **Warning!** Air-purifying respirators do not protect workers in oxygen-deficient atmospheres. If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent skin contact. Butyl rubber and polycarbonate are suitable materials. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.⁽¹⁰³⁾ **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove Sb_2O_3 from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using Sb_2O_3 , especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage/Handling Requirements: Prevent physical damage to containers. Store in a cool, dry, well-ventilated area away from incompatibles.

Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level.

Administrative Controls: Consider preplacement and periodic medical exams of exposed workers with emphasis on the skin, lungs, and heart.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Antimony compounds, inorganic, solid, n.o.s.

DOT Hazard Class: 6.1

ID No.: UN1549

DOT Packing Group: III

DOT Label: Keep away from food

Special Provisions (172.102):—

Packaging Authorizations

a) Exceptions: 173.153

b) Non-bulk Packaging: 173.213

c) Bulk Packaging: 173.240

Quantity Limitations

a) Passenger Aircraft or Railcar: 100 kg

b) Cargo Aircraft Only: 200 kg

Vessel Stowage Requirements

a) Vessel Stowage: A

b) Other: —

MSDS Collection References: 1, 26, 73, 101, 103, 124, 126, 127, 132, 133, 136, 139, 159, 167, 168, 176, 183, 186

Prepared by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** T Thoburn, MPH, MD

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Genium Publishing Corporation

One Genium Plaza
Schenectady, NY 12304-4690 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 296
Arsenic and Compounds

Issued: 4/90

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Section 1. Material Identification

Arsenic Description: Obtained from flue dust of copper and lead smelters as white arsenic (arsenic trioxide). Reduction with charcoal and sublimation in an N_2 current yields pure arsenic. Metallic arsenic is used for hardening copper, lead, and alloys; as a doping agent in germanium and silicon solid-state products, special solders, and medicine; and to make gallium arsenide for dipoles and other electronic devices. Arsenic compounds are used in manufacturing certain types of glass; in textile printing, tanning, taxidermy, pharmaceuticals, insecticides and fungicides, pigment production, and antifouling paints; and to control sludge formation in lubricating oils. Arsenic trioxide is the source for 97% of all arsenic products.

Other Designations: CAS No. 7440-38-2; arsen; arsenic black; As; gray arsenic; metallic arsenic.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*⁽⁷³⁾ for a suppliers list.

R 1
I 4
S 2
K 0

Genium



HMIS
H 3
F 2
R 2
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Arsenic and soluble compounds, as As

OSHA PEL

8-hr TWA: 0.5 mg/m³, * 0.01 mg/m³†

NIOSH REL, 1987

Ceiling: 0.002 mg/m³

Toxicity Data‡

Man, oral, TD_{Lo} : 76 mg/kg administered intermittently over a 12-year period affects the liver (tumors) and blood (hemorrhage)

Man, oral: 7857 mg/kg administered over 55 years produces gastrointestinal (in the structure or function of the esophagus), blood (hemorrhage), and skin and appendage (dermatitis) changes

Rat, oral, TC_{Lo} : 605 µg/kg administered to a 35-week pregnant rat affects fertility (pre- and post-implantation mortality)

* Organic compounds.

† Inorganic compounds.

‡ See NIOSH, *RTECS* (CG0525000), for additional mutative, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: sublimates at 1134 °F/612 °C

Melting Point: 1497 °F/814 °C

Vapor Pressure: 1 mm at 702 °F/372 °C (sublimes)

Atomic Weight: 74.92

Density: 5.724 at 57 °F/14 °C

Water Solubility: Insoluble†

Appearance and Odor: A brittle, crystalline, silvery to black metalloid. Odorless.

* This data pertains to arsenic only.

† Arsenic is soluble in nitric acid (HNO_3).

Section 4. Fire and Explosion Data

Flash Point: None reported

Autoignition Temperature: None reported

LEL: None reported

UEL: None reported

Extinguishing Media: Use dry chemical, CO_2 , water spray, or foam to fight fires.

Unusual Fire or Explosion Hazards: Flammable and slightly explosive in the form of dust when exposed to heat or flame.

Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Arsenic is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Arsenic can react vigorously on contact with powerful oxidizers such as bromates, peroxides, chlorates, iodates, lithium, silver nitrate, potassium nitrate, potassium permanganate, and chromium (VI) oxide. This material is also incompatible with halogens, bromine azide, palladium, dirubidium acetylide, zinc, and platinum.

Hazardous Products of Decomposition: Thermal oxidative decomposition of arsenic and its compounds produces irritating or poisonous gases.

Section 6. Health Hazard Data

Carcinogenicity: The IARC, NTP, and OSHA list arsenic as a human carcinogen (Group 1). This evaluation applies to arsenic and arsenic compounds as a whole, and not necessarily to all individual chemicals within the group. Studies report that both the trivalent and pentavalent compounds are strongly implicated as causes of skin, lung, and lymphatic cancers. Experimental studies have shown that arsenic has tumorigenic and teratogenic effects in laboratory animals.

Summary of Risks: Arsenic compounds are irritants of the skin, mucous membranes, and eyes. The moist mucous membranes are most sensitive to irritation. Prolonged contact results in local hyperemia (blood congestion) and later vesicular or pustular eruption. Epidermal carcinoma is reported risk of exposure. Peripheral neuropathy (degenerative state of the nervous system) is common after acute or chronic arsenic poisoning. Symptoms include decreased sensation to touch, pinprick, and temperature; loss of vibration sense; and profound muscle weakness and wasting. Other complications of acute and chronic arsenic poisoning are encephalopathy (alterations of brain structure) and toxic delirium.

Medical Conditions Aggravated by Long-Term Exposure: Damage to the liver, nervous, and hematopoietic (responsible for the formation of blood or blood cells in the body) system may be permanent. Pulmonary and lymphatic cancer may also occur.

Target Organs: Liver, kidneys, skin, lungs, lymphatic system.

Primary Entry Routes: Inhalation, ingestion of dust and fumes, via skin absorption.

Acute Effects: Acute industrial intoxication is more likely to arise from inhalation of arsine. However, with corrosive arsenical vapors, conjunctivitis, eyelid edema, and even corneal erosion may result. Inhalation may result in nasal irritation with perforation of the septum, cough, chest pain, hoarseness, pharyngitis, and inflammation of the mouth. If ingested, metallic or garlic taste, intense thirst, nausea, vomiting, abdominal pain, diarrhea, and cardiovascular arrhythmias (heartbeat irregularities) may occur. Symptoms generally occur within 30 minutes, but may be delayed for several hours if ingested with food. Acute poisoning may result in acute hemolysis (breakdown of red blood cells).

Chronic Effects: Chronic symptoms include weight loss, hair loss, nausea, and diarrhea alternating with constipation, palmar and plantar hyperkeratoses (thickening of the corneous layer of skin on palms and soles of feet), and skin eruptions, and peripheral neuritis (inflammation of the nerves). Leukemia, bone marrow depression, or aplastic anemia (dysfunctioning of blood-forming organs) may occur after chronic exposure.

FIRST AID

Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.

Skin: Quickly remove contaminated clothing. After rinsing affected skin with flooding amounts of water, wash it with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have a conscious person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Physician's Note: If emesis is unsuccessful after two doses of ipecac, consider gastric lavage. Monitor urine arsenic level. Alkalinization of urine may help prevent disposition of red cell breakdown products in renal tubular cells. If acute exposure is significant, maintain high urine output and monitor volume status, preferably with central venous pressure line. Abdominal X-rays should be done routinely for all ingestions. Chelation therapy with BAL, followed by n-penicillamine is recommended, but specific dosing guidelines are not clearly established.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of spill, evacuate all unnecessary personnel, remove all heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against dust inhalation and contact with skin and eyes. Use nonsparking tools. With a clean shovel, scoop material into a clean, dry container and cover. Absorb liquid material with sand or noncombustible inert material and place in disposal containers. Do not release to sewers, drains, or waterways. Follow applicable OSHA regulations (29 CFR 1910.120).

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations*

RCRA Hazardous Waste (40 CFR 261.33): Not listed

Listed as a CERCLA Hazardous Substance† (40 CFR 302.4), Reportable Quantity

(RQ): 1 lb (0.454 kg) † per Clean Water Act, Sec. 307(a); per Clean Air Act, Sec. 112)

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations†

Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

* Designations for arsenic only.

† Listed as arsenic organic compounds (as As).

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.

Warning: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.

Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PELs, ACGIH TLVs, and NIOSH REL (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.⁽¹⁰³⁾

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in closed, properly labeled, containers in a cool, well-ventilated area away from all incompatible materials (Sec. 5) and heat and ignition sources. Protect containers from physical damage.

Engineering Controls: Avoid inhalation or ingestion of dust and fumes, and skin or eye contact. Practice good personal hygiene and housekeeping procedures. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program with training, maintenance, inspection, and evaluation. All engineering systems should be of maximum explosion-proof design and electrically grounded and bonded. Provide preplacement and annual physical examination with emphasis on the skin, respiratory system, and blood.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Arsenic, solid

DOT Hazard Class: Poison B

ID No.: UN1558

DOT Label: Poison

DOT Packaging Requirements: 173.366

DOT Packaging Exceptions: 173.364

IMO Shipping Name: Arsenic, metallic

IMO Hazard Class: 6.1

IMO Label: Poison

IMDG Packaging Group: II

ID No.: UN1558

MSDS Collection References: 7, 26, 38, 53, 73, 85, 87, 88, 89, 100, 103, 109, 123, 124, 126, 127, 130, 136, 138

Prepared by: MJ Allison, BS; Industrial Hygiene Review: DJ Wilson, CIH; Medical Review: MJ Hardies, MD



Genium Publishing Corporation

One Genium Plaza
Schenectady, NY 12304-4690 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 15
Asbestos and Asbestos-containing Materials

Issued: 11/90

Section 1. Material Identification

Asbestos and Asbestos-containing Materials Description: Asbestos is a generic term applied to many naturally occurring, hydrated silicates (minerals) found in rock which separate into flexible fibers when crushed or processed. Commercially important forms are amosite, anthrophyllite (mined and used only in Finland), chrysotile, and crocidolite. Other types include tremolite and actinolite. Most widely used in US industry is chrysotile, a fibrous form of serpentine. Since asbestos is insensitive to chemical attack and incombustible, there are over 2000 uses as processed fiber. It is added to such diverse materials as cement, vinyl, plaster, asphalt, and cotton, although due to its health hazards other materials are now replacing it wherever possible. Its use is now limited to products that bind fibers within the product. The largest use of asbestos is in asbestos cement for pipes in water supply, sewage disposal, and irrigation systems; ducts; and flat and corrugated sheets for a wide variety of construction applications. Other uses include fire-resistant textiles, floor tiles, underlayment and roofing papers, friction materials (brake linings), reinforcing filler in elastomers for packing and gaskets, reinforcing pigment in surface coatings and sealants, thermal and electrical insulation media, as a component of taping compound and industrial talcs, and as filler in industrial greases. About 98% of crocidolite is used in production of asbestos cement pipe. Between 1950 and 1972 asbestos was used as spray insulation in buildings, but OSHA now prohibits spray application of actinolite, anthrophyllite, asbestos, or tremolite (29 CFR 1910.1001).

Other Designations: CAS No. 12172-73-5, amosite, brown asbestos; CAS No. 1332-21-4, asbestos; CAS No. 12001-29-5, chrysotile, white asbestos; CAS No. 12001-28-4, crocidolite, blue asbestos; Ascarite; earth flax; mountain cork; stone flax.

Molecular Formulas: Amosite, $(\text{FeMg})\text{SiO}_3$; anthrophyllite, $(\text{MgFe})_7\text{Si}_8\text{O}_{22}(\text{OH})_2$; chrysotile, $3\text{MgO} \cdot 2\text{SiO}_2 \cdot \text{H}_2\text{O}$; crocidolite, $\text{NaFe}(\text{SiO}_3)_2 \cdot \text{FeSiO}_3 \cdot \text{H}_2\text{O}$; tremolite, $\text{Ca}_2\text{Mg}_5\text{Si}_8\text{O}_{22}(\text{OH})_2$.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*⁽⁷³⁾ for a suppliers list.

Cautions: Asbestos causes three specific diseases: asbestosis (fibrous lung scarring), lung cancer, and mesothelioma (cancer of the chest lining and abdominal cavities). Prevent or maintain exposures at the lowest feasible level.

33

R 0
I 4
S 1
K 0

Genium



HMS
H 3
F 0
R 0
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

	1989 OSHA PELs*	1990-91 ACGIH TLVs	1988 NIOSH REL
Asbestos	TWA: 0.2 f/cc†	TWA: 2.0 f/cc§	0.1 f/cc
Amosite	0.2 f/cc	0.5 f/cc	0.1 f/cc
Chrysotile	0.2 f/cc	2.0 f/cc	0.1 f/cc
Crocidolite	0.2 f/cc	0.2 f/cc	0.1 f/cc

1985-86 Toxicity Data for Asbestos (CAS No. 1332-21-4)**

Human, inhalation, TC_{50} : 1.2 fb/cc, continuous exposure over 19 years. Toxic to lungs.

* OSHA has proposed a lower asbestos exposure limit of 0.1 f/cc as an 8-hr TWA (*Industrial Safety and Hygiene News*, 8/90).

† Fiber/cm³

‡ Average over a 30-min sampling period.

§ As determined by membrane filter method at 400 to 450X magnification (4-mm objective) phase contrast illumination. Fibers longer than 5 µg and with an aspect ratio ≥ 3:1 (ACGIH).

** See NIOSH, RTECS (CI6475000), for additional toxicity data.

Section 3. Physical Data

Melting Point: Decomposes

Molecular Weight: Varies with asbestos form (Sec. 1)

Appearance and Odor: White or greenish (chrysotile), blue (crocidolite), or gray-green (amosite) fibrous, odorless solids.

Section 4. Fire and Explosion Data

Flash Point: None reported

Autoignition Temperature: None reported

LEL: None reported

UEL: None reported

Extinguishing Media: Asbestos is nonflammable. Use dry chemical, CO_2 , water spray, or regular foam. Do not scatter spilled material with high-pressure water streams. **Special Fire-fighting Procedures:** Isolate hazard area and deny entry. Since there may be airborne asbestos fibers, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode; structural firefighter's protective clothing provides limited protection. If feasible, remove containers from fire area. Avoid dust generation. Be aware of runoff from fire control methods. Do not release to sewers or waterways. Develop decontamination procedures for protective clothing and equipment.

Section 5. Reactivity Data

Stability/Polymerization: Asbestos is inert under ordinary room temperature and heated use conditions. It is heat resistant, but decomposes and alters its microscopic fiber structure above 600 °C (1112 °F). Chrysotile dehydroxylates at 1112 to 1436 °F (600 to 780 °C); the "asbestos anhydride" in turn breaks down to a mixture of silica (SiO_2) and forsterite (Mg_2SiO_4) at 1472 to 1562 °F (800 to 850 °C). Above 1832 °F (1000 °C) magnesium pyroxenes form and melt at ~2642 °F (1450 °C). **Chemical Incompatibilities:** Strong acids can attack chrysotile and rapidly extract its MgO and H_2O content; glacial acetic acid can decompose it. Hot water slowly breaks down chrysotile. Like other asbestos forms, it resists strong alkali (5M NaOH at least up to 100 °C).

Section 6. Health Hazard Data

Carcinogenicity: The NTP, IARC, OSHA, and ACGIH list asbestos as a human carcinogen. **Summary of Risks:** Asbestos may cause 1) asbestosis, 2) lung cancer, 3) mesothelioma, 4) pleural plaques, and 5) several other forms of cancer. **Asbestosis** is fibrosis (scarring) of lung tissue after many years of high-level occupational exposure. Scarring may be progressive even after exposure ceases. Even though detectable in lungs of a high proportion of adults in industrialized areas, asbestosis does not result from lower level environmental exposure. Its symptoms range from mild shortness of breath and dry cough to severe disabling breathlessness, heart failure, and ultimately death. Lung scarring can be seen on X-ray and alterations in lung function can be detected with spirometry (a medical test). Examination typically detects rales (crackling sounds in lungs). Severe cases may have cyanosis (bluish skin discoloration) and clubbing of fingertips. **Lung cancer** can result from lower exposure levels than asbestosis, but also takes many years to develop. Smokers exposed to asbestos are at 5 to 10X higher risk than exposed nonsmokers. **Mesothelioma** is a very aggressive cancer of the pleura (lining around the lungs) or peritoneum (lining of the abdomen), and develops after decades of (sometimes low level) exposure. Symptoms may include chest and abdominal pain, weight loss, and/or shortness of breath, with death within 2 years of diagnosis. **Pleural plaques** are thickenings, sometimes with calcium deposits, of the lungs's lining and may be seen on X-ray. While not associated specifically with health effects, they indicate significant exposure. **Other sites of cancer** include larynx (vocal cords), portions of digestive tract, and possibly the kidney. Asbestos's toxicity depends on fiber type (crocidolite > amosite > chrysotile), size (longer > shorter), shape (long, thin needle-like > curly), and solubility. Health effects depend on dose (exposure concentration and duration), smoking habits, and individual susceptibility. Prevent or maintain exposures at lowest feasible level.

Continue on next page

Section 6. Health Hazard Data, continued

Medical Conditions Aggravated by Long-Term Exposure: Long-term, high-level exposure may aggravate any chronic lung (asthma, emphysema, bronchitis) or heart condition. **Target Organs:** Respiratory system; possibly digestive system. **Primary Entry Routes:** Inhalation, ingestion, dermal contact. **Acute Effects:** Nose, throat, skin and eye irritation are possible with high exposure. **Chronic Effects:** Asbestosis, lung cancer, and mesothelioma typically develop decades (20 to 40 years) after exposure begins, but may occur sooner. **FIRST AID Emergency:** **Personnel should protect against asbestos exposure.** Eyes: Do not rub. Gently lift eyelids and flush with flooding amounts of water. **Skin:** Shower with water and soap. Wet contaminated clothing prior to removal and seal in a plastic bag for disposal as hazardous waste. If rash develops, consult physician. **Inhalation:** Remove to fresh air. Clean any fibers from nose and mouth. Encourage victim to cough, spit, and blow nose to remove fibers. **Ingestion:** Induce vomiting only if awake and alert. Consult a physician. **After first aid, consult medical care provider.** **Note to Physicians:** Asbestos diagnosis is based on chest X-ray with an abnormal ILO "B" reading (small irregular opacities), sales, restrictive pattern spirometry, adequate exposure history, and symptoms. Consider pneumovax, annual flu shot, and other supportive treatment as needed.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel and evacuate all unnecessary personnel. Cleanup personnel should protect against dust inhalation and skin or eye contact. Avoid dust generation, blowing, dry brushing, and dry mopping. Provide HEPA-filtered (high-efficiency particulate air) portable ventilation systems. Use wet cleaning methods or approved HEPA vacuum cleaning system to pick up spills. The techniques used must collect particulate without dispersing dust into air. Place waste in properly labeled dust-tight containers or sealed, heavy-gauge, impervious plastic bags for disposal. Follow applicable OSHA regulations (29 CFR 1910.120). **Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

RCRA Hazardous Waste (40 CFR 261.33): Not listed

Listed as CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* per Clean Water Act, Sec. 307(a); Clean Air Act, Sec. 112]

Listed as a SARA Toxic Chemical (40 CFR 372.65)

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

OSHA Designations

Listed as Air Contaminant (29 CFR 1910.1000, Table Z-1-A, Z-3)

Section 8. Special Protection Data

Note: Do not substitute personal protective clothing or equipment for proper handling and engineering controls. **Goggles:** Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For airborne concentration of asbestos, tremolite, anthophyllite, actinolite, or a combination of these minerals not in excess of 2 f/cc (10 X PEL), use a half-mask air-purifying respirator, other than a disposable respirator, equipped with high-efficiency filters; not in excess of 10 f/cc (50 X PEL), a full facepiece air-purifying respirator equipped with high-efficiency filters; not in excess of 20 f/cc (100 X PEL), any powered air-purifying respirator equipped with high-efficiency filters or any supplied-air respirator operated in continuous flow mode; not in excess of 200 f/cc (1000 X PEL), a full facepiece supplied-air respirator operated in pressure-demand mode and equipped with an auxiliary positive-pressure self-contained breathing apparatus (29 CFR 1910.1001). **Warning!** Air-purifying respirators do not protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact. **Ventilation:** Provide general and local exhaust ventilation and dust collection systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into work area by controlling it at its source.⁽¹⁰³⁾ **Safety Stations:** Make available in work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Never wear contact lenses in the work area; soft lenses may absorb, and all lenses concentrate, irritants. Never enter lunchroom facilities or leave workplace wearing clothing or equipment worn during workshift. Separate contaminated work clothes from street clothes. **If proper hygiene is not rigorously followed, family members can be exposed to asbestos fibers.** Place contaminated protective devices or work clothing in labeled, impermeable, and sealed containers or bags. Do not remove asbestos from clothing by blowing or shaking. Launder contaminated clothing before wearing. Inform laundering service of asbestos-contaminated clothing and of asbestos' potential harmful effects (29 CFR 1910.1001). **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using asbestos, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in closed (dust-tight) containers or heavy-gauge impervious plastic bags in a clean, secure area protected from physical damage. Do not open containers that can release asbestos dust without providing proper enclosure or control measure. **Engineering Controls:** Educate workers about asbestos's and asbestos-containing materials' hazards. Inform employees of asbestos standard (29 CFR 1910.1001). Exposure to asbestos, tremolite, anthophyllite, and actinolite in construction work is covered by 29 CFR 1926.58. ["OSHA is proposing an expanded requirement for a trained 'competent person' to ensure compliance with the standard on all construction operations involving asbestos, and requiring more stringent housekeeping to remove asbestos in general industry." (*Industrial Safety and Hygiene News*, 8/90).] Instruct employees in proper practices for handling asbestos-containing materials and correct use of protective equipment. Prevent or minimize asbestos exposure. Regulate areas where exposure in excess of the PEL is likely. Post warning signs in all regulated areas (see legend below). Work with asbestos only in a sufficient wet state to prevent emission of airborne fibers. Practice good personal hygiene and housekeeping procedures. Do not substitute personal protective equipment for proper handling and engineering controls. If exposures exceed the PEL, ensure employees wear appropriate protective clothing. Inhaling or ingesting asbestos fibers from contaminated clothing or skin can be hazardous. Do not allow dusts and asbestos-containing wastes to accumulate. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Monitor work areas that expose employees to airborne concentrations at or above the action level (Sec. 2). Whenever production, process, control equipment, personnel, or work practices change, institute new monitoring. **Other Precautions:** Medical surveillance is required for all employees possibly exposed at or above the action level. Provide preplacement medical examination that includes complete medical and work history, complete physical examination that emphasizes respiratory and cardiovascular systems and digestive tract, the respiratory disease standardized questionnaire, a posterior-anterior 14" x 17" chest roentgenogram, and pulmonary function tests [FVC and FEV(1)]. Annual periodic medical examinations shall include all these elements and an abbreviated questionnaire. If it is 10+ years since first asbestos exposure, an individual should have a chest roentgenogram every 5 years (ages 15 to 35), every 2 years (ages 35 to 45), every year (age 45+). Within 30 days of employment termination, an individual should receive a periodic medical examination with the elements listed above. Keep medical surveillance records for duration of employment, plus 30 years.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Asbestos

DOT Hazard Class: ORM-C

ID No.: -

DOT Label: None

DOT Packaging Exceptions: 173.1090

DOT Packaging Requirements: 173.1090

Other Requirements: Stow and handle to avoid airborne particle

IMO Shipping Name: Asbestos, blue; asbestos, white

IMO Hazard Class: 9

ID No.: UN2212, UN2590

IMO Label: None

IMDG Packaging Group: II, III

DANGER

ASBESTOS

CANCER AND LUNG DISEASE HAZARD

AUTHORIZED PERSONNEL ONLY

RESPIRATORS AND PROTECTIVE CLOTHING ARE REQUIRED IN THIS AREA

MSDS Collection References: 2-4, 6, 12, 14, 20, 26, 32, 38, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 138-140, 142, 143, 146, 148, 152, 153, 156-158
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH;
Medical Review: MJ Upfal, MD, MPH; **Edited by:** JR Stuart, MS



Genium Publishing Corporation

One Genium Plaza
Schenectady, NY 12304-4690 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 59
Beryllium Metal/Powder

Issued: 4/80

Revision: A, 11/89

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Section 1. Material Identification

Beryllium Metal/Powder Description: A naturally occurring ore found in chrysoberyl (Be_2SiO_5) or produced industrially from beryl ($3\text{Be} \cdot \text{OAl}_2\text{O}_3 \cdot 6\text{SiO}_2$). The ore is converted to the oxide or hydroxide, then to the fluoride or chloride. The halide may be reduced in a furnace by magnesium metal or by electrolysis. An alternative purification process is a liquid-liquid extraction with an organophosphate chelating agent. Used in aerospace structures, radio tube parts, inertial guidance systems, computer parts, Be-Cu alloys, gyroscopes; used as an additive in solid propellant rocket fuels, as a neutron source when bombarded with alpha particles, and as a neutron moderator and reflector in nuclear reactors.

Other Designations: Glucinium; Be; CAS No. 7440-41-7.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.

R 1
I 4
S 2
K 1

Genium



HMIS

H 4

F 1

R 0

PPG*

* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Beryllium and compounds, ca 100%

OSHA PELs

8-hr TWA: 0.002 ppm

30-min STEL: 0.005 ppm

Ceiling level: 0.025 ppm

ACGIH TLV, 1989-90*

TLV-TWA: 0.002 mg/m³

NIOSH REL, 1987*

Not to exceed 0.5 µg/m³

Toxicity Data†

Human, inhalation, TC_{Lo} : 300 mg/m³, pulmonary effects

Rabbit, intravenous, TD_{Lo} : 20 mg/kg, neoplastic effects

* These values are for beryllium and its compounds.

† See NIOSH, RTECS (DS1750000), for additional data with references to mutagenic and tumorigenic effects.

Section 3. Physical Data

Boiling Point: 5378 °F (2970 °C)

Melting Point: 2332 °F (1278 °C)

Vapor Pressure: 7.6 mm Hg at 3470 °F (1910 °C)

Atomic Weight: 9.01 g/mol

Specific Gravity ($\text{H}_2\text{O} = 1$ at 39 °F (4 °C)): 1.848 at 68 °F (20 °C)

Water Solubility, hot water: Slight

cold water: Insoluble

Appearance and Odor: A grayish-white metal with a hexagonal and anisotropic crystal structure (i.e., their index of refraction varies with incident light direction), and a powdered metal, no odor.

Section 4. Fire and Explosion Data

Flash Point: None reported **Autoignition Temperature:** Powder, ca 1200 °F (649 °C) **LEL:** None reported **UEL:** None reported

Extinguishing Media: *Never* use water or CO_2 . Instead, smother the fire with an approved dry-powder extinguisher. Sand, graphite powder, and sodium chloride are also recommended.

Unusual Fire or Explosion Hazards: Beryllium can be a moderate fire hazard if exposed to flame. The hazards increase as particulate size decreases. A beryllium dust cloud can be explosive (areas where dusting may occur require Class 2, Group E electrical services, 29 CFR 1910.309). This material's combustion products are *highly toxic*.

Special Fire-fighting Procedures: Fire fighters should use full protective clothing, eye protection, and a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. After exposure to a beryllium fire, they should clean equipment and bathe carefully.

Section 5. Reactivity Data

Stability/Polymerization: Beryllium is stable at room temperature in closed containers.* Hazardous polymerization cannot occur.

Chemical Incompatibilities: Acid and alkali soluble, it reacts with strong bases to evolve hydrogen.† Warm beryllium reacts incandescently with phosphorus, fluorine, or chlorine. Molten lithium metal at 356 °F (180 °C) severely attacks beryllium metal.

Conditions to Avoid: When heated in air or in mixed CO_2 and nitrogen, beryllium is ignitable. Mixtures of the powdered metal with CCl_4 or trichloroethylene flash on heavy impact.

Hazardous Products of Decomposition: Thermal oxidative decomposition of beryllium emits very toxic oxide of beryllium fumes.

* When moist, beryllium forms thin, acid-resistant oxide films on solid surfaces.

† A simple asphyxiant gas, hydrogen is extremely flammable.

Section 6. Health Hazard Data

Carcinogenicity: The NTP, IARC, and ACGIH list beryllium as a carcinogen. Animal studies also indicate that beryllium produces lung and bone tumors.

Summary of Risks: Beryllium is highly toxic by inhalation of fume or dust and exposure to this element and its salts may cause death. Inhaled beryllium is partially deposited in the lungs, the blood system, and finally the bones, thus affecting all organ systems. Since the human body does not quickly eliminate beryllium, trace amounts in urine are detectable as long as 10 years after exposure. Prolonged or repeated skin contact can cause skin irritation or dermatitis. Eye contact can produce conjunctivitis and eye ulcers. If introduced through the skin via cuts or punctures, nonhealing ulcers may develop.

Continue on next page

Section 6. Health Hazard Data, continued

Medical Conditions Aggravated by Long-Term Exposure: Increased risk of lung, liver, gall bladder, and bile duct cancers. **Target Organs:** Lungs, mucous membranes, eyes, skin. **Primary Entry:** Inhalation. **Acute Effects:** Symptoms may occur up to 72 hr after a massive exposure. Acute inhalation can produce pneumonitis with inflammation of the upper and lower respiratory tracts, nasal congestion, nonproductive coughing and pulmonary edema. High dose exposures may cause acute respiratory distress, brain hemorrhaging, liver inflammation, and spleen hemorrhaging. **Chronic Effects:** Symptoms may be delayed up to 15 years. Chronic exposures result from long-term exposure to small (microgram) quantities and can produce berylliosis. Berylliosis is a progressive granuloma formation in the lungs which eventually causes increasing shortness of breath and, in some cases, death. Since it also circulates among other organs, beryllium causes eventual heart enlargement and failure, liver and spleen enlargement, kidney stones, various malignant tumors, and damaging cell death in any organ in which it accumulates.

FIRST AID

Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min. **Skin:** After rinsing affected area with flooding amounts of water, wash it with soap and water. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. If ingested, have that conscious person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear. Present studies indicate that beryllium is so poorly absorbed through the intestinal tract, that ingestion is not an important hazard (*Industrial Toxicology*, 3rd Edition, Hamilton). **After first aid, get appropriate in-plant, paramedic, or community medical attention and support.** Watch for signs of respiratory deterioration, and use oxygen as needed.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: If powdered metal is spilled, notify safety personnel. Evacuate area except for cleanup personnel with protective equipment against contact or inhalation hazards. Provide ventilation and remove heat and ignition sources. To prevent dusting conditions, vacuum or wet mop powder spills. Collect particulate scrap, absorb on paper, and transfer to a sealed recovery or disposal container. **Disposal:** Dissolve beryllium in a small amount of 6M-HCl, filter it, and add a slight excess of 6M-NH₄OH to the filtrate using litmus as an indicator (blue at pH 8.3). Heat and coagulate the precipitate. After 12 hr, filter and dry it. Handle beryllium waste unsuitable for recycling in accordance with Federal, state, and local regulations. Dispose of scrap or waste material by arranging its return to the supplier in a mutually acceptable form. Contact your supplier or a licensed contractor for detailed recommendations.

OSHA Designations

Listed as Air Contaminant (29 CFR 1910.1000, Table Z-2)

EPA Designations

RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 100 lb (45.4 kg) [* per RCRA, Sec. 3001; per Clean Water Act, Sec. 307(a), 112]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Wear a NIOSH-approved respirator for emergency and nonroutine use in concentrations above the 8-hr, 2- $\mu\text{g}/\text{m}^3$ TWA. For any time period, a half-mask, air-purifying respirator with a high-efficiency filter is suitable for concentrations as high as 25- $\mu\text{g}/\text{m}^3$ (see NIOSH, *A Recommended Standard for Occupational Exposure to Beryllium*, Sec. 4). A powered, air-purifying respirator equipped with a "fume filter" is suitable for concentrations up to 40 $\mu\text{g}/\text{m}^3$. A full facepiece, air-purifying respirator with a high-efficiency filter is suitable for concentrations up to 100 $\mu\text{g}/\text{m}^3$. A powered, air-purifying respirator equipped with a high-efficiency filter, operating in the positive-pressure mode, is suitable for concentrations up to 1000 $\mu\text{g}/\text{m}^3$. An SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode is suitable for concentrations above 1000 $\mu\text{g}/\text{m}^3$. Follow OSHA respirator regulations (29 CFR 1910.134). **Warning:** Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. When exposure levels exceed the TLV, change into clean protective clothing and shower at the end of your shift. **Ventilation:** Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL standards (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103). **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing. Remove this material from your shoes and equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Clearly label and store beryllium away from incompatible materials (Sec. 5) in a clean, dry, low fire-hazard area. Protect containers from physical damage. **Engineering Controls:** Provide adequate ventilation in areas where beryllium can become airborne. Monitor these areas with personal samplers to limit and control exposure levels. Teach workers about beryllium's potential hazards. Practice good house-keeping to prevent accumulation of beryllium-containing deposits. Give preplacement and annual medical exams (chest x-rays, baseline pulmonary function tests [FVC, (functional vital capacity) and FEV₁ (the amount of air exhaled in the first second after maximum inhalation)] and body weight measurements to workers possibly exposed to concentrations above the TLV. Prevent exposing those with pulmonary disease, chronic skin, liver, heart, or kidney conditions; abnormal chest x-ray or blood count; or vital capacity depression greater than 10%. Ensure all engineering systems (production, transportation) are of maximum explosion-proof design. To prevent static sparks, electrically ground and bond all containers and pipelines used in shipping, transferring, reacting, producing, and sampling operations.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Beryllium compound, n.o.s.

DOT Hazard Class: Poison B

DOT ID No.: UN1567

IMO Shipping Name: Beryllium, metal powder

IMO Hazard Class: 6.1

IMO Label: Poison, flammable solid

MSDS Collection References: 1-12, 18-20, 24-26, 81, 84, 85, 88-91, 100, 116, 117

Prepared by: MJ Allison, BS; Industrial Hygiene Review: DJ Wilson, CIH; Medical Review: Warren Silverman, MD

**Section 1. Material Identification**

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Cadmium Metal/Powder (Cd) Description: Occurs naturally in the mineral greenockite (cadmium sulfide). This form is rare and most cadmium is obtained by extraction from other ores containing it as a mineral (lead, copper, and zinc). Zinc sulfide ores are the main source; by direct distillation or recovery from the electrolytic process. Used in electroplating other metals, fire protection systems, nickel-cadmium storage batteries, power transmission wire, TV phosphors, pigments for ceramic glazes, machinery enamels, baking enamels, photography and lithography, selenium rectifiers, electrodes for cadmium-vapor lamps, and photoelectric cells; as a fungicide and a Weston standard cell control of atomic fission in nuclear reactors.

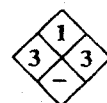
Other Designations: CAS No. 7440-43-9, colloidal cadmium.

Manufacturer: Contact your supplier/distributor. Consult latest *Chemical Week Buyers' Guide*⁽⁷³⁾ for suppliers list.

Cautions: Cadmium is a highly toxic metal. Symptoms may be delayed several hours and include pulmonary edema (fluid in lungs) which can be fatal. Chronic effects include kidney damage. Cd is considered a carcinogen by several government agencies. The powder is pyrophoric and presents a significant fire/explosion hazard.

Powder

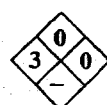
HMIS	R	3	
H	3*	I	4
F	1	S	2
R	3	K	3



Genium

Solid

HMIS	R	1	
H	3*	I	4
F	0	S	2
R	0	K	1



*Chronic effects PPE-Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Cadmium, ca 100%

1992 OSHA PEL8-hr TWA: 5 µg/m³**1992 OSHA SECAL***TWA: 15 or 50 µg/m³**1990 IDLH Level**50 mg/m³**1993-94 ACGIH TLVs**TWA: 0.01 mg/m³ (total dust), Class A2 carcinogenTWA: 0.002 mg/m³ (respirable fraction)**1991 DFG (Germany) MAK**

None established

1992 NIOSH REL

Carcinogen, keep as low as possible

1992 Toxicity Data†Human, inhalation, LC₅₀: 39 mg/m³/20 min caused cardiac changes, thrombosis, and respiratory depression.Rat, oral, LD₅₀: 225 mg/kg; details not reported.Woman, inhalation, LC₅₀: 129 µg/m³ for 20 continuous years produced lung tumors.Man, TC₅₀: 88 µg/m³/8.6 years caused kidney and ureter toxicity with protein in the urine.

* Separate engineering control limit: to be achieved in processes and work places where it is not possible to achieve the PEL through engineering and work practices alone. The SECAL for Cd is 15 or 50 µg/m³ depending on the processes involved. See Federal Register 57 (178): 42222, Table VIII-B1, 9/14/92.

†See NIOSH, RTECS (EU9800000), for additional mutation, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data**Boiling Point:** 1409 °F (765 °C)**Melting Point:** 610 °F (321 °C)**Vapor Pressure:** 0.095 mm Hg at 609.6 °F (320.9 °C)**Refraction Index:** 1.13**Mohs Hardness:** 2.0**Molecular Weight:** 112.4**Density:** 8.642**Water Solubility:** Insoluble**Other Solubilities:** Soluble in nitric (rapidly), hydrochloric (slowly), and other acids. The solid is soluble in ammonium nitrate solution, but the powdered form undergoes an explosive reaction.**Appearance and Odor:** Silver-white, blue-tinged, lustrous, odorless, soft metal that is easily cut with a knife. The powder is grayish-white.**Section 4. Fire and Explosion Data****Flash Point:** None reported**Autoignition Temperature:** None reported**LEL:** None reported**UEL:** None reported

Extinguishing Media: The solid metal is not flammable, but the finely divided powder is pyrophoric. As a rule, the more finely divided the powder is, the greater the potential for explosion. Use carbon dioxide, dry chemical, or sand. **Unusual Fire or Explosion Hazards:** Processes that create cadmium dust such as cutting, grinding, or welding present a serious explosion hazard in presence of ignition sources. Avoid creation of cadmium dust clouds. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Do not release runoff from fire control methods to sewers or waterways; dike for proper disposal.

Section 5. Reactivity Data

Stability/Polymerization: Cadmium easily tarnishes in moist air as it is oxidized to cadmium oxide. The solid is stable in dry air. The powder is pyrophoric. Cd becomes brittle at 176 °F (80 °C). Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Include ammonium nitrate (powdered Cd), hydrazoic acid, tellurium, zinc, ammonia, sulfur, selenium, nitryl fluoride, and oxidizing agents. **Conditions to Avoid:** Creation of Cd dust clouds, exposure to heat and ignition sources, and contact with incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of Cd can produce toxic cadmium oxide (CdO) fumes.

Section 6. Health Hazard Data

Carcinogenicity: The following agencies list Cd as a carcinogen: IARC Class 2A (probably carcinogenic in humans),⁽¹⁸³⁾ NTP Class 2 (reasonably anticipated to be a carcinogen),⁽¹⁶⁹⁾ and NIOSH Class X (carcinogen defined without further categorization),⁽¹⁸³⁾ ACGIH TLV-A2 (suspected human carcinogen),⁽¹⁸³⁾ EPA-B1 (Probable human carcinogen) and DFG MAK-A2 (unmistakably carcinogenic in animal experimentation only).⁽¹⁸³⁾

Summary of Risks: Dust or fume inhalation generally results in acute symptoms delayed up to 24 hr. Effects include a flu-like syndrome similar to metal fume fever with chills, fever, and muscle pain in the back and limbs. Pulmonary edema (fluid in lungs) can develop after severe exposure and may result in death. If victim recovers, residual changes may include lung fibrosis (thickening) and vascular changes. Long-term exposure to Cd damages the liver and kidneys (accumulates, half-life = 7 to 30 yr). Proteinuria (protein in urine) of low molecular weight is the first sign of tubular dysfunction. Excess urinary glucose is also seen. Bone demineralization similar to osteoporosis (decreased bone density)...

Continue on next page

Section 6. Health Hazard Data, continued

occurs *not* as a direct effect of Cd exposure, but indirectly by altering kidney regulation of calcium and phosphorus which are needed for strong, healthy bones. Some studies show a correlation between anemia (low hemoglobin in blood) and high Cd levels. Selenium (Se) and zinc (Zn) appear to suppress Cd toxicity: Se binds up Cd, preventing it from entering body tissue and Zn may compete for the same metabolic site. **Medical Conditions Aggravated by Long-Term Exposure:** Kidney, blood, or respiratory disorders. **Target Organs:** Blood, kidney, liver, respiratory system. **Primary Entry Routes:** Inhalation, ingestion. **Acute Effects:** Inhalation may cause irritation of the eyes, nose, and throat, nausea and vomiting, abdominal colic, diarrhea, chest tightness, cough, headache, and weakness. Pulmonary edema could develop up to 24 hr post exposure. Kidney damage may occur after acute exposures, but is more likely with chronic exposure. **Chronic Effects:** Symptoms may be delayed several years after last exposure and include perforation of the nasal septum (tissue between the nostrils), loss of smell, chronic bronchitis, severe progressive emphysema, anorexia, insomnia, fatigue, pallor, anemia, kidney damage, bone demineralization, lung fibrosis and possible cancer of the respiratory tract.

FIRST AID

Eyes: Do not allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin: Quickly remove contaminated clothing. Wash exposed area with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless otherwise advised, have that conscious and alert person drink 1 to 2 glasses of water to dilute. Do not induce vomiting because of cadmium's irritating nature.

Note to Physicians: B-2 microglobulin excretion of > 200 µg/g creatinine indicates kidney dysfunction as does a renal cortex [Cd] of 180 to 220 µg/g of wet kidney cortex. Blood Cd levels are *not* indicative of exposure.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off ignition sources. Cleanup personnel should protect against inhalation. Carefully scoop up small spills and place in sealed impermeable containers. Do not disperse dust by sweeping. Remember that Cd powder can be pyrophoric and must be handled carefully. Prevent entry into sewers, drains, and waterways. Follow applicable OSHA regulations (29 CFR 1910.120).

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.24): D006, Characteristic of Toxicity; regulatory level = 1.0 mg/L

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 10 lb (4.54 kg)† [* per CWA, Sec. 307(a)]

SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1027)

† No reporting of releases of this substance is required if the diameter of the pieces of the solid metal is equal to or exceeds 100 µm (0.004 in.)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For any detectable concentration, use a SCBA or supplied air respirator (with auxiliary SCBA) with a full facepiece operated in pressure-demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. **Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.** If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear gloves, boots, aprons, and gauntlets to prevent Cd dust from contacting skin. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL or SECAL (Sec. 2). Lunchroom facilities should not have concentrations above 2.5 µg/m³ at any time. Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.⁽¹⁰³⁾ **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes; launder before reuse. Remove Cd from shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using Cd, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage/Handling Requirements: Store in a cool, dry, well-ventilated area away from heat, ignition sources, and incompatibles. Do not allow cadmium dust to build up in storage area.

Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level.

Administrative Controls: Prohibit workers from removing Cd from protective clothing and equipment by blowing, shaking, or any other means that disperses Cd into the air. Employees must not enter eating facilities while wearing PPE unless it is vacuumed with a HEPA. Consider preplacement and periodic medical exams of exposed workers emphasizing the blood, kidneys, liver, and respiratory system. Educate workers on Cadmium's carcinogenicity.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Poisonous solids, n.o.s.*,

Packaging Authorizations

Pyrophoric metals, n.o.s.†

a) Exceptions: 173.153*, None†

DOT Hazard Class: 6.1*, 4.2†

b) Non-bulk Packaging: 173.213*, .187†

ID No.: UN2811*, UN1383†

c) Bulk Packaging: 173.240*, .242†

DOT Packing Group: III*, I†

DOT Label: Keep away from food*, Spontaneously Combustible†

Special Provisions (172.102): —*, B11†

* Solid metal, † Powder

Quantity Limitations

a) Passenger Aircraft or Railcar: 100 kg*,

Forbidden†

b) Cargo Aircraft Only: 200 kg*, Forbidden†

Vessel Stowage Requirements

a) Vessel Stowage: A*, D†

b) Other: —

MSDS Collection References: 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 148, 159, 167, 169, 183, 185, 186

Prepared by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** TW Thoburn, MPH, MD



Genium Publishing Corp.

One Genium Plaza
Schenectady, NY 12304-4690
(518) 377-8854

Material Safety Data Sheet Collection

Cesium Hydroxide

MSDS No. 201

Date of Preparation: 1/87

Revision: A, 4/96

Section 1 - Chemical Product and Company Identification

48

Product/Chemical Name: Cesium Hydroxide

Chemical Formula: CsOH

CAS Number: 21351-79-1

Synonyms: cesium hydrate

Derivation: Produced by electrolysis of cesium salts or by adding barium hydroxide to an aqueous solution of cesium sulfate.

General Use: Used in storage battery electrolytes for sub-zero temperatures, in color photography, and as a catalyst in the polymerization of cyclic siloxanes.

Vendors: Consult the latest *Chemical Week Buyers' Guide*. (73)

Section 2 - Composition / Information on Ingredients

Cesium hydroxide, ca 100 %wt

OSHA PEL

Vacated 1989 Final Rule Limit

8-hr TWA: 2 mg/m³

ACGIH TLV

TWA: 2 mg/m³

NIOSH REL

10-hr TWA: 2 mg/m³

DFG (Germany) MAK

None established

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Cesium hydroxide exists as colorless, white, or yellowish crystals. It readily absorbs moisture from air and surfaces. It is the strongest known base and is highly corrosive to all body surfaces.

Potential Health Effects

Primary Entry Routes: Inhalation, skin and eye contact.

Target Organs: Eyes, skin, respiratory tract.

Acute Effects: Because cesium hydroxide is used in such small quantities, toxicity data for industrial exposures is little or non-existent. However, it is becoming more widely used which may result in future toxic exposures.

Because cesium is similar to lithium, it is expected that overexposure may result in central nervous system effects.

Inhalation: Inhalation of dusts can cause severe irritation and possible burns of the respiratory tract. The severity is due to cesium hydroxide's ability to extract moisture from the mucous membranes.

Eye: Corrosive. May cause permanent damage.

Skin: Highly irritating and can be corrosive, especially if skin is moist.

Ingestion: Severe irritation and possible burns of the gastrointestinal tract.

Carcinogenicity: ACGIH, IARC, NTP, and OSHA do not list cesium hydroxide as a carcinogen.

Medical Conditions Aggravated by Long-Term Exposure: None reported.

Chronic Effects: None reported.

Other: Cesium hydroxide has been shown not to be a sensitizer in animal studies.

**Wilson
Risk
Scale**

R 1
I 3
S 4
K 1

HMIS

H 3
F 0
R 0

PPE*

*Sec. 8

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician or ophthalmologist immediately.

Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Gently wash exposed area with soap and water. For reddened or blistered skin, consult a physician.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water to dilute. *Do not* induce vomiting due to the corrosive nature of cesium hydroxide. Vomiting can compound the damage to the gastrointestinal tract and pose additional respiratory damage if aspirated.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Treat alkali burns as for thermal burns. Use copious irrigation.

Section 5 - Fire-Fighting Measures

Flash Point: Noncombustible.

Autoignition Temperature: Noncombustible.

LEL: None reported.

UEL: None reported.

Flammability Classification: Noncombustible solid.

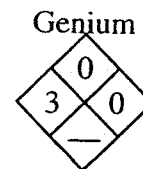
Extinguishing Media: Use agents suitable for surrounding fire. Be aware that water may be used, but that it can create a large amount of heat.

Unusual Fire or Explosion Hazards: Use agents suitable for surrounding fire. If water is used, flooding amounts are needed to minimize the exothermic reaction with cesium hydroxide. Material may become molten.

Hazardous Combustion Products: None reported.

Fire-Fighting Instructions: Do not release runoff from fire control methods to sewers or waterways.

Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode.

**Section 6 - Accidental Release Measures**

Spill /Leak Procedures: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Cleanup personnel must protect against inhalation and skin/eye contact.

Small Spills: Carefully scoop up or vacuum (with appropriate filter) and place in suitable containers.

Large Spills

Containment: Flush spill to containment area with flooding quantities of water (enough to prevent exothermic reaction with cesium hydroxide) for later reclamation or disposal. Do not release into sewers or waterways.

Cleanup: Damp mop any residue.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Use only in a fume hood and with appropriate PPE.

Storage Requirements: Store in a cool, dry, well-ventilated area. Keep containers tightly closed to prevent absorption of moisture and exposure to carbon dioxide. It must be stored in platinum or silver containers. Glass containers are not suitable due to reaction with glass. Store away from water sources and incompatibles (Sec. 10).

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Enclose processes where possible to prevent dust dispersion into work areas.

Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source. (103)

Administrative Controls: Consider preplacement and periodic medical exams (including lung function tests) of exposed workers, especially those exposed to the action level (1 mg/m^3) or above.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. High-efficiency particulate respirators may be necessary for protection. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Polyvinyl chloride is considered appropriate PPE material. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.

Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.

Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove cesium hydroxide from your shoes and clean personal protective equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using cesium hydroxide, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties**Physical State:** Solid**Appearance and Odor:** Colorless, white, or yellowish crystals.**Vapor Pressure:** ~0 mm Hg at 68 °F (20 °C)**Formula Weight:** 149.92**Density (H₂O=1, at 4 °C):** 3.68 g/mL**Water Solubility:** Highly soluble; 395% at 59 °F (15 °C)**Other Solubilities:** Soluble in alcohol.**Melting Point:** 521.6 °F (272 °C)**Section 10 - Stability and Reactivity****Stability:** Cesium hydroxide is stable at room temperature in closed containers under normal storage and handling conditions.
Polymerization: Hazardous polymerization does not occur.**Chemical Incompatibilities:** Glass, carbon dioxide, water, strong acids (hydrochloric, sulfuric, nitric), and metals (aluminum, lead, zinc, tin). Contact with wet metals can evolve highly flammable and explosive hydrogen gas.**Conditions to Avoid:** Exposure to water and other incompatibles.**Hazardous Decomposition Products:** None reported.**Section 11 - Toxicological Information****Toxicity Data: *****Eye Effects:**

Rabbit, eye: 5 mg/5 min rinse caused severe irritation.

Acute Oral Effects:Rat, oral, LD₅₀: 570 mg/kg caused somnolence, muscle contraction or spasticity, and respiratory changes.Mouse, oral, LD₅₀: 800 mg/kg caused tetany.**Skin Effects:**

Rabbit, skin: 5 mg/24 hr caused mild irritation.

* See NIOSH, RTECS (FK9800000), for additional toxicity data.

Section 12 - Ecological Information**Ecotoxicity:** Data not found.**Environmental Fate:** Data not found.**Section 13 - Disposal Considerations****Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.**Section 14 - Transport Information****DOT Transportation Data (49 CFR 172.101):****Shipping Name:** Cesium hydroxide, solid*; Cesium hydroxide, solution†**Shipping Symbols:** -**Hazard Class:** 8**ID No.:** UN2682*, UN2681†**Packing Group:** II**Label:** Corrosive**Special Provisions (172.102):** -*;
B2, T8†**Packaging Authorizations**

a) Exceptions: 173.154

b) Non-bulk Packaging:

173.212*; 202†

c) Bulk Packaging: 173.240*;

242†

Quantity Limitations

a) Passenger, Aircraft, or Railcar: 15 kg*; 1 L†

b) Cargo Aircraft Only: 50 kg*; 30 L†

Vessel Stowage Requirements

a) Vessel Stowage: A

b) Other: -

Section 15 - Regulatory Information**EPA Regulations:**

Classified as a RCRA Hazardous Waste (40 CFR 261.22): Characteristic of Corrosivity, D002

Listed as a "Unlisted Hazardous Waste, Characteristic of Corrosivity" CERCLA Hazardous Substance (40 CFR 302.4) per RCRA, Sec. 3001

CERCLA Reportable Quantity (RQ), 100 lb (45.4kg)

SARA Toxic Chemical (40 CFR 372.65): Not listed

SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed

OSHA Regulations:

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 16 - Other Information**References:** 73, 103, 124, 136, 176, 190, 197, 201, 203, 209

Prepared By M Gannon, BA
Industrial Hygiene Review PA Roy, MPH, CIH
Medical Review J Brent, MD, PhD

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Genium Publishing Corporation
One Genium Plaza
Schenectady, NY 12304-4690 USA
(518) 377-8854

Sheet No. 83
Chromium Metal/Powder

Issued: 3/81

Revision: A, 11/89

30

Section 1. Material Identification

Chromium Metal/Powder Description: Obtained from chrome ore, chromite (FeCr_2O_4), by electrolysis of chromium solutions, by direct reduction (ferrochrome), and by reducing the oxide with finely divided carbon or aluminum. Used for chromeplating other metals; for greatly increasing metal resistance and durability; in manufacturing chrome-steel or chrome-nickel-steel alloys (stainless steel); as a constituent of inorganic pigments; as protective coating for automotive and equipment accessories; and in nuclear and high-temperature research.

Other Designations: Chrome; Cr; CAS No. 7440-47-3.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.

R 1
I 4
S 1
K 1

Genium



HMIS
H 2
F 1
R 1
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Chromium metal/powder, ca 100%

OSHA PEL

ACGIH TLV, 1988-89*

NIOSH REL, 1987[†]

Toxicity Data[‡]

8-hr TWA: 1 mg/m³

TLV-TWA: 0.5 mg/m³

8-hr TWA (for chromium metal
and insoluble salts): 1 mg Cr/m³

Rat, implant, TD_{50} : 1200 µg/kg body weight
administered intermittently over six weeks

* This TLV is applicable to Cr^{2+} and Cr^{3+} compounds. For water soluble and water-insoluble Cr^{6+} , the 8-hr TWA is 0.05 mg Cr^{6+} /m³. Certain water-insoluble Cr^{6+} compounds (zinc chromate, calcium chromate, lead chromate, barium chromate, strontium chromate, and sintered chromium trioxide) are designated as A1a (human carcinogen).

[†] The NIOSH REL (10-hr TWA) for carcinogen Cr^{6+} compounds is 1 µg/m³; for noncarcinogenic Cr^{6+} compounds (including chromic acid), the RELs (10-hr TWAs) are 25 µg/m³ and 50 µg/m³ (15-min ceiling). The noncarcinogenic compounds include mono- and dichromates of hydrogen, cesium, sodium, lithium, potassium, rubidium, ammonia, and Cr^{6+} (chromic acid anhydride). Any and all Cr^{6+} materials excluded from the noncarcinogenic group above are carcinogenic Cr^{6+} compounds.

[‡] See NIOSH, *RTECS* (GB4200000), for additional data with references to tumorigenic effects.

Section 3. Physical Data

Boiling Point: 4788 °F (2642 °C)

Atomic Weight: 51.996 g/mol

Melting Point: 3452 °F (1900 °C)

Specific Gravity ($\text{H}_2\text{O} = 1$ at 39 °F (4 °C)): 7.2 at 68 °F (20 °C)

Vapor Pressure: 1 mm Hg at 2941 °F (1616 °C)

Water Solubility: Insoluble

Vapor Density (Air = 1): 1.79

Appearance and Odor: Steel-gray, lustrous metal; no odor.

Section 4. Fire and Explosion Data

Flash Point: None reported Autoignition Temperature: Cloud, 1076 °F (580 °C); dust layer, 752 °F (400 °C)

LEL: Dust cloud explosion,
0.230 oz/ft³

UEL: None reported

Extinguishing Media: Use dry chemical or sand.

Unusual Fire or Explosion Hazards: Particle size and dispersion in air determine reactivity. Chromium powder explodes spontaneously in air, while chromium dust suspended in CO_2 is ignitable and explosive when heated.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

*One hundred percent of dust goes through a 74-µm sieve. A 140-mJ spark can ignite a dust cloud.

Section 5. Reactivity Data

Stability/Polymerization: Chromium is stable when properly handled and stored. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Chromium reacts readily with dilute, not nitric, acids to form chromous salts. It is soluble in acids (not nitric) and strong alkalis. Its powder is incompatible with strong oxidizing agents, including high O_2 concentration. Evaporation of mercury (Hg) from Cr amalgam leaves pyrophoric chromium. Finely divided Cr attains incandescence with nitrogen oxide, potassium chlorate, and sulfur dioxide. Molten lithium at 18 °C severely attacks Cr. Fused ammonium nitrate below 200 °C reacts explosively and may ignite or react violently with bromine pentafluoride.

Hazardous Products of Decomposition: Thermal oxidative decomposition of Cr can produce toxic chromium oxide fumes.

Section 6. Health Hazard Data

Carcinogenicity: The NTP and OSHA list chromium as a human carcinogen.

Summary of Risks: When ingested chromium is a human poison, with gastrointestinal (GI) effects. Chromium 3 (Cr^3) compounds show little or no toxicity. Less soluble chromium 6 (Cr^6) compounds are suspected carcinogens and severe irritants of the larynx, nasopharynx, lungs, and sinusal tract, renal damage, and circulatory shock. Chromium metal (when heated to high temperatures) and insoluble salts are said to be involved in histological fibrosis of the lungs, which may progress to clinically evident pneumoconiosis. Exposure to chromate dust and powder can cause skin (dermatitis) and eye irritation (conjunctivitis).

Medical Conditions Aggravated by Long-Term Exposure: An increased incidence of bronchogenic carcinoma occurs in workers exposed to chromate dust.

Target Organs: Respiratory system.

Primary Entry: Inhalation, percutaneous absorption, and ingestion.

Acute Effects: Acute exposures to dust may cause headache, coughing, shortness of breath, pneumoconiosis, fever, weight loss, nasal irritation, inflammation of the conjunctiva, and dermatitis.

Chronic Effects: Asthmatic bronchitis.

FIRST AID

Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.

Skin: Brush off chromium dust. After rinsing affected area with flooding amounts of water, wash it with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that conscious person slowly drink 1 to 2 glasses of water to dilute. Do not induce vomiting. A physician should evaluate all ingestion cases.

After first aid, get appropriate in-plant, paramedic, or community medical attention and support.

Physician's Note: Acute toxicity causes a two-phase insult: 1) multisystem shock due to gastrointestinal corrosivity and 2) hepatic, renal, hematopoietic insult. Treatment should use ascorbic acid as a neutralizer with gastric lavage. If the ingestion is substantial, exchange transfusions and/or consider hemodialysis. Treat allergic dermatitis with local cortisone or 10% ascorbic acid to reduce Cr^6 to Cr^3 . Ten percent EDTA in a lanolin base applied every 24 hr helps heal skin ulcers.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of large spills. Cleanup personnel should wear protective clothing and approved respirators. Remove heat and ignition sources. Provide adequate ventilation. Keep airborne dust at a minimum. Remove spills quickly and place in appropriate containers for disposal or reuse.

Disposal: Reclaim salvageable metal. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)

EPA Designations

RCRA Hazardous Waste (40 CFR 261.33): Not listed

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* per Clean Water Act, Sec. 307(a)]

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: Wear a NIOSH-approved respirator if necessary. Wear an SCBA with a full facepiece when the particle concentration's upper limit is 50 mg/m³.

Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.

Other: Wear impervious rubber gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact.

Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA standard

(Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103).

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing. Remove this material from your shoes and equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store material in cool, dry, well-ventilated area separate from acids and oxidizing agents. Seal and protect containers from physical damage. Keep away from heat or ignition sources.

Engineering Controls: Avoid dust inhalation. Practice good housekeeping (vacuuming and wet sweeping) to minimize airborne particulates and to prevent dust accumulation. Use nonsparking tools and ground electrical equipment and machinery.

Transportation Data (49 CFR 172.101, .102): Not listed

MSDS Collection References: 1, 2, 26, 38, 80, 87, 88, 89, 100, 109, 124, 126

Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD



Genium Publishing Corporation

One Genium Plaza
Schenectady, NY 12304-4690 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 757
Coal Tar Creosote

Issued: 7/91

Section 1. Material Identification

Coal Tar Creosote (molecular formula varies with purity) Description: Three main derivations: by distillation of coal tar produced by high-temperature carbonization of bituminous coal; by mixing strained naphthalene oil, wash oil, and strained or light anthracene oil; as a by-product of conventional coal coking. It typically contains up to 160 chemicals, mainly aromatic compounds such as phenol, pyrol and pyridine. Used mainly as a wood preservative for railroad ties, poles, fence posts, marine pilings, and other lumber for outdoor use; as a water-proofing agent, fuel oil constituent, frothing agent for mineral separation, hop defoliant, and lubricant for die molds; in manufacturing chemicals; and in medicine as an antiseptic, disinfectant, antipyretic, astringent, germicide, and styptic.

Other Designations: CAS No. 8001-58-9, Awpa,® brick oil, Caswell No. 225,® coal tar oil, creosote, creosote oil, creosotum, cresylic creosote, heavy oil, liquid pitch oil, naphthalene oil, Preserv-o-sote,® Sakresote,® tar oil, wash oil.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*® for a suppliers list.

Cautions: Flammable, liquid coal tar creosote is toxic by inhalation, ingestion, and skin contact. The IARC and NTP classify it as a *human carcinogen*.

R 1
I 4
S 4*
K 2
* Skin absorption

34
NFPA
2
2
0
-
HMIS
H 2
F 2
R 0
PPG†
† Sec. 8

* Skin absorption can occur with phenol, a major component of coal tar creosote.

Section 2. Ingredients and Occupational Exposure Limits

Coal tar creosote, ca 100%

1990 OSHA PEL
8-hr TWA: 0.2 mg/m³*

1990-91 ACGIH TLV
TWA: 0.2 mg/m³*

1987 IDLH Level
700 mg/m³

1990 NIOSH REL
0.1 mg/m³ (cyclohexane extractable portion)

1985-86 Toxicity Data†

Rat, oral, LD₅₀: 725 mg/kg; toxic effects not yet reviewed
Dog, oral, LD₅₀: 600 mg/kg; toxic effects not yet reviewed
Rat, TD₀₁: 52,416 mg/kg administered during 91 days prior to mating produces reproductive effects on fallopian tubes and ovaries
Mouse, skin, TD₀₁: 99 g/kg produces tumors in skin and appendages

* As coal tar pitch volatiles.

† See NIOSH, RTECS (GF8615000), for additional mutation, reproductive, tumorigenic, and other toxicity data.

Section 3. Physical Data

Boiling Point: 381 to 752 °F (194 to 400 °C)
Distillation Range: 446 to 554 °F (230 to 290 °C)
Heat of Combustion: -12,500 Btu/lb
Heat of Vaporization: 107 Btu/lb

Molecular Weight: Varies with purity
Density/Specific Gravity: 1.07 to 1.08 at 68 °F (20 °C)
Water Solubility: Slightly soluble

Appearance and Odor: Pure coal tar creosote is colorless, but the industrial product is a yellow to black oily liquid with an aromatic smoky smell and a burning caustic taste.

Section 4. Fire and Explosion Data

Flash Point: 165.2 °F (74 °C), CC Autoignition Temperature: 637 °F (336 °C) LEL: None reported UEL: None reported

Extinguishing Media: For small fires, use dry chemical, carbon dioxide (CO₂), or regular foam. For large fires, use fog or regular foam. Since water is least effective, use it as an extinguishing agent only when the preferred measures are unavailable. However, use water spray to cool fire-exposed containers.

Unusual Fire or Explosion Hazards: Vapors may travel to an ignition source and flash back. Containers may explode in heat of fire. Coal tar creosote presents a vapor explosion hazard indoors, outdoors, and in sewers.

Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Also, wear full protective clothing. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if impossible, withdraw from area and let fire burn. Immediately leave area if you hear a rising sound from venting safety device or notice any fire-caused tank discoloration. Isolate area for 1/2 mile in all directions if fire involves tank, rail car or tank truck. Be aware of runoff from fire control methods. Do not release to sewers or waterways. Fully decontaminate or properly dispose of personal protective clothing.

Section 5. Reactivity Data

Stability/Polymerization: Coal tar creosote is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Creosote oil mixed with chlorosulfonic acid in a closed container causes an increase in temperature and pressure.

Conditions to Avoid: Avoid excessive heat and contact with chlorosulfonic acid.

Hazardous Products of Decomposition: Thermal oxidative decomposition of coal tar creosote can produce oxides of carbon and thick, black, acrid smoke.

Section 6. Health Hazard Data

Carcinogenicity: In 1990 reports, the IARC, NTP, and OSHA list coal tar creosote as a carcinogen.

Summary of Risks: Coal tar creosote is toxic by inhalation, ingestion, and skin contact. It contains a variety of hydrocarbons such as phenol and polycyclic aromatic hydrocarbons such as benzo[a]pyrene, benzanthracene, and phenol derivatives. The range of toxicity depends on the exposure concentration, amount, and duration. Effects may include irritation, burns, and several forms of cancer.

Medical Conditions Aggravated by Long-Term Exposure: Chronic respiratory or skin diseases.

Target Organs: Eyes, skin, bladder, kidneys, and respiratory system.

Primary Entry Routes: Inhalation, ingestion, and skin contact.

Acute Effects: Skin contact may cause irritation, burning, itching, redness, pigment changes, dermatitis (a rash of redness and small bumps), or burns. Photosensitization (worsening of rash with exposure to sunlight) may occur. Inhalation may be irritating to the respiratory tract. Eye contact may cause conjunctivitis (inflammation of the eye's lining), keratitis (corneal inflammation), or corneal burns with scarring. Ingestion may result in nausea, vomiting, abdominal pain, rapid pulse, respiratory distress, and shock. Systemic absorption by any route (including skin absorption) may cause trouble breathing, thready (continuous or drawn out) pulse, dizziness, headache, nausea, vomiting, salivation, and convulsions. Exposure to large doses (particularly by ingestion) may be fatal.

Chronic Effects: Dermatitis, skin cancer, and lung cancer.

FIRST AID

Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Do not let victim rub eyes or keep them tightly closed. Consult a physician immediately.

Skin: Quickly remove contaminated clothing. Wash affected area with soap and flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that conscious person drink 1 to 2 glasses of milk or water. Do not induce vomiting!

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Cresol may be detected in urine.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel. Isolate hazard area, deny entry, and stay upwind of spills. Shut off all ignition sources—no flares, smoking, or flames in hazard area. Cleanup personnel should protect against vapor inhalation and skin or eye contact. If possible with no risk, stop leak. Water spray may be used to reduce vapor but it may not prevent ignition in closed spaces. For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers for later disposal. For large spills, dike far ahead of liquid spill for later disposal. Follow applicable OSHA regulations (29 CFR 1910.120).

Environmental Degradation: Coal tar creosote is fouling to shoreline. Ecotoxicity values are: TL₅₀, goldfish (*Carassius auratus*), 3.51 ppm/24 hr (60:40) mixture of creosote and coal tar; LD₅₀, bob white quail (*Colinus virginianus*), 1,260 ppm/8 days (60:40) mixture of creosote and coal tar.

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.33), Hazardous Material No. U051

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* per RCRA, Sec. 3001]

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations

Listed (as coal tar pitch volatiles) as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Since contact lens use in industry is controversial, establish your own policy.

Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. **Warning!** Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent all skin contact. Applying a layer of petroleum jelly or lanolin castor oil ointment to the face reduces vapor contact and penetration through skin. Frequent change of protective garments is an additional protective measure.

Ventilation: Provide general and local exhaust ventilation systems equipped with high-efficiency particulate filters to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.⁽¹⁰⁾

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Take particular care to avoid any contamination of drains or ventilation ducts. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Avoid physical damage to containers. Store in a cool, dry, well-ventilated area. Store coal tar creosote as close to area of use as possible to minimize transporting distance.

Engineering Controls: Use engineering controls to keep airborne concentrations below the OSHA PEL. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Always perform synthesis and purification procedures under a vertical ventilation hood and make regular operational safety checks. Label doors to rooms where coal tar creosote is produced, used, or stored as containing a carcinogen. Locate emergency equipment at well-marked and clearly identified stations in case emergency escape is necessary.

Other Precautions: Preplacement and periodic medical examinations of exposed workers emphasizing respiratory, skin, liver, and kidney disorders, including comprehensive work and medical history, physical examination, CXR, PFTs, urinalysis, LFT, and sputum cytology as the attending physician considers appropriate. Educate workers about coal tar creosote's carcinogenicity and proper handling procedures to avoid exposure.

Other Comments: Caution is in order when handling or sawing old creosote-treated lumber since it retains a considerable portion of creosote for up to 25 to 30 years.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Creosote

DOT Hazard Class: Flammable liquid

ID No.: UN1136

DOT Label: Flammable liquid

MSDS Collection References: 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 138, 139, 140, 142, 143, 146, 148, 153, 159

Prepared by: M Gannon, BA; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** Mark Upfal, MD, MPH; **Edited by:** JR Stuart, MS



Material Safety Data Sheet

Genium Publishing Corporation

One Genium Plaza
Schenectady, NY 12304-4690 USA
(518) 377-8854

No. 82

COBALT METAL/POWDER
(Revision A)
Issued: March 1981
Revised: April 1988

SECTION 1. MATERIAL IDENTIFICATION

25

Material Name: COBALT METAL/POWDER

Description (Origin/Uses): Used in alloys and in nuclear weapons.

Other Designations: Co; NIOSH RTECS No. GF8750000; CAS No. 7440-48-4

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

Comments: The hazards of working with cobalt metal/powder are associated with cutting, grinding, welding, etc., that produce dust, fumes, powders, and gases.

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F 1	R 1
R 1	I 4
PPG*	S 1
*Sec sect. 8	K -

SECTION 2. INGREDIENTS AND HAZARDS

%

EXPOSURE LIMITS

Cobalt Metal/Powder, CAS No. 7440-48-4

Ca 100

IDLH* Level: 20 mg/m³

OSHA PEL
8-Hr TWA: 0.1 mg/m³

ACGIH TLVs, 1987-88
TLV-TWA: 0.05 mg/m³
TLV-STEL: 0.1 mg/m³

Toxicity Data**
Rat, Oral, LD₅₀: 1500 mg/kg

All the exposure limits above are defined for cobalt metal, dust, and fume as Co.

*Immediately dangerous to life and health.

**See NIOSH, RTECS, for additional data with references to tumorigenic effects.

SECTION 3. PHYSICAL DATA

Boiling Point: Ca 5792°F (3200°C)
Melting Point: 2719°F (1493°C)
Specific Gravity (H₂O = 1): 8.92

Water Solubility (%): Insoluble
Molecular Weight: 59 Grams/Mole

Appearance and Odor: A gray, hard, magnetic, ductile, and somewhat malleable metal or black powder; odorless.

SECTION 4. FIRE AND EXPLOSION DATA

LOWER

UPPER

Flash Point and Method

Autoignition Temperature

Flammability Limits in Air

*

*

% by Volume

*

*

Extinguishing Media: *Do not use water. Recommended extinguishing agents include dry sand, dry dolomite, dry graphite powder, or sodium chloride. Solid cobalt does not burn; however, its dust can burn and it may form explosive mixtures with air.

Unusual Fire or Explosion Hazards: Cobalt dust particles suspended in the air can explode. If a cobalt dust cloud does form, immediately eliminate all possible sources of ignition such as sparks, open flame, etc., and take appropriate precautions (e.g., spray the affected area with a water mist or fog). Pyrophoric cobalt, which appears as a black powder, burns brilliantly when exposed to air. Working with this material can produce heat and sparks, which can ignite flammable materials and vapors in the workplace.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Cobalt metal/powder is stable in closed containers at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization.

Chemical Incompatibilities: Pyrophoric cobalt decomposes cold acetylene and becomes incandescent. Fused ammonium nitrate can sometimes react explosively with powdered cobalt.

Conditions to Avoid: Prevent contact with incompatible chemicals. Powdered cobalt is more reactive than the solid metal; do not allow the powder to accumulate or form a potentially explosive dust cloud.

Hazardous Products of Decomposition: Only powdered cobalt can burn; various oxides of cobalt may be produced during fires.

SECTION 6. HEALTH HAZARD INFORMATION

Cobalt metal/powder is not listed as a carcinogen by the NTP, IARC, or OSHA.

Summary of Risks: Inhalation of cobalt dust can cause pulmonary symptoms such as wheezing, irritation of the upper respiratory tract (URT), and hypersensitivity reactions (asthma). Skin contact with powdered cobalt may cause dermatitis, especially in the creases of the elbows, knees, ankles, and neck. Contact with eyes may cause conjunctivitis. Ingestion may produce a hot sensation along with vomiting, diarrhea, and nausea. **Medical Conditions Aggravated by Long-Term Exposure:** Disorders of the skin and the URT may be worsened by exposure to cobalt; administer preplacement and periodic medical exams emphasizing these functions.

Target Organs: Respiratory system, skin, bladder, kidneys, and eyes. **Primary Entry:** Skin contact, inhalation.

Acute Effects: Contact dermatitis and breathing difficulties. **Chronic Effects:** Allergic asthma, restricted pulmonary functions, and interstitial fibrosis may be caused by long-term occupational exposure to cobalt or its compounds.

FIRST AID

Eyes: Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes.

Skin: Immediately wash the affected area with soap and water.

Inhalation: Remove the exposed person to fresh air; restore and/or support his or her breathing as needed.

Ingestion: Never give anything by mouth to someone who is unconscious or convulsing. If cobalt salts are ingested, give 1 to 2 glasses of water and induce vomiting.

GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, evacuate all nonessential personnel, remove all sources of heat and ignition, and provide adequate ventilation. Cleanup personnel need protection against contact with and inhalation of dust (see sect. 8). Prevent skin contact. Scoop up spilled cobalt into suitable containers for disposal. Carefully sweep or vacuum up small spills or residues without creating dust.

Waste Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Consider recycling. Follow Federal, state, and local regulations.

OSHA Designations

Air Contaminant (29 CFR 1910.1000 Subpart Z, for cobalt metal, dust, and fume)

EPA Designations (40 CFR 302.4)

RCRA Hazardous Waste: Not Listed

CERCLA Hazardous Substance: Not Listed

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Follow the eye- and face-protection guidelines in 29 CFR 1910.133.

Respirator: Wear a NIOSH-approved respirator per the *NIOSH Pocket Guide to Chemical Hazards* for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow the respirator guidelines in 29 CFR 1910.134. For emergency or nonroutine use (e.g., cleaning reactor vessels or storage tanks), wear an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres.

Other: Wear impervious gloves; boots; aprons; and clean, impervious body-covering clothing to prevent any possibility of skin contact.

Barrier creams may be useful to limit the effects of skin contact. **Ventilation:** Install and operate general and local ventilation systems powerful enough to maintain airborne levels of cobalt metal, dust, or fume below the OSHA PEL standard cited in section 2.

Safety Stations: Make eyewash stations, washing facilities, and safety showers available in use and handling areas.

Contaminated Equipment: Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.

Particles can adhere to contact lenses and cause corneal damage. Do *not* wear contact lenses in any work area.

Comments: Practice good personal hygiene; always wash thoroughly after using this material. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale dust or create dusty working conditions.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store cobalt metal/powder in a cool, dry, well-ventilated area in closed containers away from oxidizing agents, incompatible chemicals (see sect. 5), and sources of heat or ignition.

Special Handling/Storage: Practice good housekeeping techniques that minimize accumulation of dust; cleaning procedures should not create dusty conditions.

Transportation Data (49 CFR 172.101-2): Not Listed

References: 1, 2, 12, 73, 84-94, 100, 103. PJI

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Prepared by PJ Igoe, BS

Industrial Hygiene Review: DJ Wilson, CIH

Medical Review: MJ Hardies, MD



Genium Publishing Corporation

One Genium Plaza
Schenectady, NY 12304-4690 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 162
Copper

Issued: 12/85

Revision: A, 8/90

32

Section 1. Material Identification

Copper (Cu) Description: Widely distributed in nature in elemental state, arsenites, sulfides, chlorides, and carbonates. Prepared by crushing, grinding, and concentrating copper ores by flotation and leaching or by smelting copper ore concentrates to yield a blister (96 to 98%) copper which is electrolytically refined to yield 99.9+% copper. Copper is the most widely used structural metal, next to iron and aluminum. Used in electric wiring; switches, heating, plumbing, roofing, and building construction; alloys (brass, bronze, Monel metal, beryllium-copper); coins; chemical and pharmaceutical machinery; electroplated protective coatings and undercoats for nickel, chromium, zinc, etc., cooking utensils; insecticides; antifouling paints; and as a catalyst. Copper whiskers are used in thermal and electrical composites. Copper flakes are used as insulation for liquid fuels.

Other Designations: CAS No. 7440-50-8, bronze powder, copper slag-airborne, copper slag-milled.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*⁽⁷³⁾ for a suppliers list.

Cautions: *Copper may be toxic through contact, inhalation, and ingestion.* It may cause skin and eye irritation and metal fume fever. Copper is not considered a fire hazard, but fine particles may burn in air.

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F 0
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PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Copper, ca 100%

1989 OSHA PELs

8-hr TWA: 1 mg/m³*

8-hr TWA: 0.1 mg/m³†

1989-90 ACGIH TLVs

TLV-TWA: 1 mg/m³*

TLV-TWA: 0.2 mg/m³†

1988 NIOSH REL

None established

1985-86 Toxicity Data†

Human, oral, TD_{Lo}: 120 µg/kg affects the gastrointestinal tract (nausea or vomiting)

Rat, oral, TD_{Lo}: 1210 µg/kg (35 weeks prior to mating) affects fertility (pre- and post-implantation mortality)

* Copper dusts and mists, as Cu.

† Copper fume.

‡ See NIOSH, RTECS (GL5325000), for additional reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 4703 °F (2595 °C)

Melting Point: 1981 °F (1083 °C)

Vapor Pressure: 1 mm Hg at 2962 °F (1628 °C)

Molecular Weight: 63.546

Density/Specific Gravity: 8.94

Water Solubility: Insoluble

Appearance and Odor: Solid, various shapes, odorless, red/brown-colored metal or powder. Copper is ductile, tough, and easily worked. It is very resistant to corrosion, but readily attacked by alkalis.

Section 4. Fire and Explosion Data

Flash Point: None reported

Autoignition Temperature: None reported

LEL: None reported

UEL: None reported

Extinguishing Media: Use extinguishing media appropriate to the surrounding fire since copper does not burn. Finely divided copper burns in air, and in extreme cases ignites spontaneously.

Unusual Fire or Explosion Hazards: Liquid copper explodes on contact with water. High concentrations of fine copper particles in the air may present an explosion hazard.

Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and a fully encapsulating suit.

Section 5. Reactivity Data

Stability/Polymerization: Copper is stable at room temperature in closed containers under normal storage and handling conditions. However, on long standing, a white, highly explosive peroxide deposit may form. Copper's vapors are uninhibited and may form polymers in vents and flame arresters.

Chemical Incompatibilities: Copper reacts violently with ammonium nitrate, bromates, iodates, chlorates, ethylene oxide, hydrazoic acid, potassium oxide, dimethyl sulfoxide + trichloroacetic acid, hydrogen peroxide, sodium peroxide, sodium azide, sulfuric acid, hydrogen sulfide + air, and lead azide. A potentially explosive reaction occurs with acetylenic compounds. Copper ignites on contact with chlorine, fluorine [above 250 °F (121 °C)], chlorine trifluoride, and hydrazinium nitrate [above 158 °F (70 °C)]. It is also incompatible with 1-bromo-2-propyne; an incandescent reaction occurs with potassium dioxide.

Conditions to Avoid: Avoid prolonged exposure to air and moisture. On exposure to moist air, copper slowly converts to the carbonate.

Hazardous Products of Decomposition: Thermal oxidative decomposition of copper can produce metallic oxides (copper fumes).

Section 6. Health Hazard Data

Carcinogenicity: The NTP, IARC, and OSHA do not list copper as a carcinogen. Experimental studies show tumorigenic and teratogenic effects in laboratory animals.

Summary of Risks: Copper is a necessary human nutrient, excessive intake levels of which the kidneys normally eliminate. In individuals with kidney disease or, rarely, Wilson's disease (abnormal retention and storage of copper in the body that damages the liver, kidneys, brain, blood, bones, and endocrine glands), copper levels may accumulate. Significant industrial exposure to copper occurs mainly through inhalation of fumes during welding, smelting, or refining operations; or through exposure to copper dusts and mists during mining, extracting, refining, or manufacturing processes. Copper particles may irritate, discolor, and damage eyes. Exposure to copper salts in many applications is potentially toxic. Copper dusts, fumes, and salts may irritate the upper respiratory tract. Long-term exposure may irritate the skin and discolor the skin or hair.

Medical Conditions Aggravated by Long-Term Exposure: Individuals with impaired pulmonary or renal function should avoid exposure.

Target Organs: Respiratory system, skin, eyes, liver, kidneys.

Primary Entry Routes: Inhalation, ingestion.

Acute Effects: Inhalation of copper fumes may give rise to metal fume fever (after an incubation period of about 5 hr), an allergic reaction with flu-like symptoms—high temperature, metallic taste, nausea, coughing, general weakness, muscle aches, and exhaustion. These symptoms usually disappear within 24 hr. Direct contact with copper causes skin and (less often) eye irritation, and itching of the linings of the nose, mouth, and respiratory tract. Exposure to copper dust may cause a greenish-black skin discoloration. Copper ingestion causes nausea, vomiting, abdominal pain, and diarrhea. Ingestion of large doses may cause stomach and intestine ulceration, jaundice, and kidney and liver damage.

Chronic Effects: Continued exposure to copper may cause mild dermatitis and degeneration of the mucous membranes. Repeated or prolonged exposure to copper dusts and mists can discolor skin and hair and irritate the skin. Repeated inhalation can cause chronic respiratory disease. Individuals with Wilson's disease (1 in 200,000 individuals) are more susceptible to chronic copper poisoning. If undetected and untreated, this progressive condition is eventually fatal.

FIRST AID

Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin: Quickly remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing with artificial respiration.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that conscious person drink 1 to 2 glasses of water, then induce vomiting.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Physician's Note: A blood count shows leucocytosis if an individual has metal fume fever. Consider chelation with penicillamine or BAL (British Anti-Lewisite or dimercaprol) for chronic intoxication.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, remove all heat and ignition sources, and provide adequate ventilation. Avoid creating dusty conditions. Cleanup personnel should protect against vapor inhalation and skin and eye contact. Cleanup methods such as vacuuming (with the appropriate filter) or wet mopping minimize dust dispersion. Absorb liquid containing copper with vermiculite, dry sand, or other inert materials. Place in appropriate containers for disposal. Follow applicable OSHA regulations (29 CFR 1910.120).

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

RCRA Hazardous Waste (40 CFR 261.33): Not listed

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 5000 lb (2270 kg) [* per Clean Water Act, 307(a)]

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. Some recommendations follow. For copper dust and mists greater than 50 mg/m³, wear a high-efficiency particulate respirator, a supplied-air respirator, or an SCBA, all with a full facepiece. For copper dust and mists greater than 2000 mg/m³, wear a supplied-air respirator equipped either with a full facepiece operated in pressure-demand or positive-pressure mode or with a hood in continuous-flow mode. For copper fumes over 100 mg/m³, wear either a powered air-purifying respirator with a high-efficiency filter, or a supplied-air respirator equipped either with a full facepiece operated in pressure-demand or positive-pressure mode or with a hood in continuous-flow mode.

Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Eye and face protection is required when grinding, welding, cutting, or remelting. Protect skin from molten metal and radiant heat when melting scrap. Machine turnings may also present a laceration hazard. When handling oil-contaminated copper, wear rubber gloves to prevent skin contact.

Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below OSHA PELs and ACGIH TLVs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.⁽¹⁰³⁾

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store copper in tightly closed containers in a cool, dry, well-ventilated area. Avoid exposure to air and moisture.

Engineering Controls: Avoid dust and fume inhalation and direct contact with skin and eyes. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good personal hygiene and housekeeping procedures. Maintain exposures below the PEL/TLV. Monitor copper dust and mist levels in the air.

Other Precautions: Provide placement and periodic examinations that emphasize the skin, eyes, and respiratory system. Prevent exposing individuals with chronic respiratory disease or Wilson's disease.

Transportation Data (49 CFR 172.101, .102): Not listed

MSDS Collection References: 26, 38, 73, 84, 88, 89, 100, 101, 103, 109, 124, 126, 127, 132, 133, 134, 136, 138, 139, 143, 144

Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD; **Edited by:** JR Stuart, MS



Genium Publishing Corporation
One Genium Plaza
Schenectady, NY 12304-4690 USA
(518) 377-8854

Sheet No. 470
Diesel Fuel Oil No. 2-D

Issued: 10/81

Revision: A, 11/90

33

Section 1. Material Identification

Diesel Fuel Oil No. 2-D Description: Diesel fuel is obtained from the middle distillate in petroleum separation; a distillate oil of low sulfur content. It is composed chiefly of unbranched paraffins. Diesel fuel is available in various grades, one of which is synonymous with fuel oil No. 2-D. This diesel fuel oil requires a minimum Cetane No. (efficiency rating for diesel fuel comparable to octane number ratings for gasoline) of 40 (ASTM D613). Used as a fuel for trucks, ships, and other automotive engines; as mosquito control (coating on breeding waters); and for drilling muds.

Other Designations: CAS No. 68334-30-5, diesel fuel.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*⁽⁷³⁾ for a suppliers list.

Cautions: Diesel fuel oil No. 2-D is a skin irritant and central nervous depressant with high mist concentrations. It is an environmental hazard and moderate fire risk.



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PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Diesel fuel oil No. 2-D*

1989 OSHA PEL	1990-91 ACGIH TLV	1988 NIOSH REL	1985-86 Toxicity Data†
None established	Mineral Oil Mist TWA: 5 mg/m ³ † STEL: 10 mg/m ³	None established	Rat, oral, LD ₅₀ : 9 g/kg produces gastrointestinal (hypermotility, diarrhea) effects

* Diesel fuel No. 2-D tends to be low in aromatics and high in paraffinics. This fuel oil is complex mixture of: 1) >95% paraffinic, olefinic, naphthenic, and aromatic hydrocarbons, 2) sulfur (<0.5%), and 3) benzene (<100 ppm). [A low benzene level reduces carcinogenic risk. Fuel oils can be exempted under the benzene standard (29 CFR 1910.1028)]. Although low in the fuel itself, benzene concentrations are likely to be much higher in processing areas.

† As sampled by nonvapor-collecting method.

‡ Monitor NIOSH, RTECS (HZ1800000), for future toxicity data.

Section 3. Physical Data

Boiling Point Range: 340 to 675 °F (171 to 358 °C)

Viscosity: 1.9 to 4.1 centistoke at 104 °F (40 °C)

Appearance and Odor: Brown, slightly viscous liquid.

Specific Gravity: <0.86

Water Solubility: Insoluble

Section 4. Fire and Explosion Data

Flash Point: 125 °F (52 °C) min.

Autoignition Temperature: >500 °F (932 °C)

LEL: 0.6% v/v

UEL: 7.5% v/v

Extinguishing Media: Use dry chemical, carbon dioxide, or foam to fight fire. Use a water spray to cool fire exposed containers. Do not use a forced water spray directly on burning oil since this will scatter the fire. Use a smothering technique for extinguishing fire.

Unusual Fire or Explosion Hazards: Diesel fuel oil No. 2-D is a OSHA Class II combustible liquid. Its volatility is similar to that of gas oil. Vapors may travel to a source of ignition and flash back.

Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective clothing. If feasible, remove containers from fire. Be aware of runoff from fire control methods. Do not release to sewers or waterways due to pollution and fire or explosion hazard.

Section 5. Reactivity Data

Stability/Polymerization: Diesel fuel oil No. 2-D is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: It is incompatible with strong oxidizing agents; heating greatly increases the fire hazard.

Conditions to Avoid: Avoid heat and ignition sources.

Hazardous Products of Decomposition: Thermal oxidative decomposition of diesel fuel oil No. 2-D can produce various hydrocarbons and hydrocarbon derivatives, and other partial oxidation products such as carbon dioxide, carbon monoxide, and sulfur dioxide.

Section 6. Health Hazard Data

Carcinogenicity: Although the IARC has not assigned an overall evaluation to diesel fuels as a group, it has evaluated occupational exposures in petroleum refining as an IARC probable human carcinogen (Group 2A). It has evaluated distillate (light) diesel oils as not classifiable as human carcinogens (Group 3).

Summary of Risks: Although diesel fuel's toxicologic effects should resemble kerosene's, they are somewhat more pronounced due to additive such as sulfurized esters. Excessive inhalation of aerosol or mist can cause respiratory tract irritation, headache, dizziness, nausea, vomiting, loss of coordination, depending on concentration and exposure time. When removed from exposure area, affected persons usually recover completely. If vomiting occurs after ingestion and if oil is aspirated into the lungs, hemorrhaging and pulmonary edema, progressing to renal involvement and chemical pneumonitis, may result. A comparative ratio of oral to aspirated lethal doses may be 1 pt vs. 5 ml. Aspiration may also result in transient CNS depression or excitement. Secondary effects may include hypoxia (insufficient oxygen in body cells), infection, pneumatocele formation, and chronic lung dysfunction. Inhalation may result in euphoria, cardiac dysrhythmias, respiratory arrest, and CNS toxicity. Prolonged or repeated skin contact may irritate hair follicles and block sebaceous glands, producing a rash of acne pimples and spots, usually on arms and legs.

Medical Conditions Aggravated by Long-Term Exposure: None reported.

Target Organs: Central nervous system, skin, and mucous membranes.

Primary Entry Routes: Inhalation, ingestion.

Acute Effects: Systemic effects from ingestion include gastrointestinal irritation, vomiting, diarrhea, and in severe cases central nervous system depression, progressing to coma or death. Inhalation of aerosols or mists may result in increased rate of respiration, tachycardia (excessively rapid heart beat), and cyanosis (dark purplish discoloration of the skin and mucous membranes caused by deficient blood oxygenation).

Chronic Effects: Repeated contact with the skin causes dermatitis.

FIRST AID

Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin: Quickly remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. If large areas of the body have been exposed or if irritation persists, get medical help immediately. Wash affected area with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, do not induce vomiting due to aspiration hazard.

Contact a physician immediately. Position to avoid aspiration.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Gastric lavage is contraindicated due to aspiration hazard. Preferred antidotes are charcoal and milk. In cases of severe aspiration pneumonitis, consider monitoring arterial blood gases to ensure adequate ventilation. Observe the patient for 6 hr. If vital signs become abnormal or symptoms develop, obtain a chest x-ray.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate area for large spills, remove all heat and ignition sources, and provide maximum explosion-proof ventilation. Cleanup personnel should protect against vapor inhalation and liquid contact. Clean up spills promptly to reduce fire or vapor hazards. Use a noncombustible absorbent material to pick up small spills or residues. For large spills, dike far ahead to contain. Pick up liquid for reclamation or disposal. Do not release to sewers or waterways due to health and fire and/or explosion hazard. Follow applicable OSHA regulations (29 CFR 1910.120). Diesel fuel oil No. 2-D spills may be environmental hazards. Report large spills.

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

RCRA Hazardous Waste (40 CFR 261.21): Ignitable waste

CERCLA Hazardous Substance (40 CFR 302.4): Not listed

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

SARA Toxic Chemical (40 CFR 372.65): Not listed

OSHA Designations

Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, use a NIOSH-approved respirator with a mist filter and organic vapor cartridge. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.

Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations that promote worker safety and productivity. Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.⁽¹⁰³⁾

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Use and storage conditions should be suitable for a OSHA Class II combustible liquid. Store in closed containers in a well-ventilated area away from heat and ignition sources and strong oxidizing agents. Protect containers from physical damage. To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations. Use nonsparking tools and explosion-proof electrical equipment. No smoking in storage or use areas.

Engineering Controls: Avoid vapor or mist inhalation and prolonged skin contact. Wear protective rubber gloves and chemical safety glasses where contact with liquid or high mist concentration may occur. Additional suitable protective clothing may be required depending on working conditions. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good personal hygiene and housekeeping procedures. Do not wear oil contaminated clothing. At least weekly laundering of work clothes is recommended. Do not put oily rags in pockets. When working with this material, wear gloves or use barrier cream.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Fuel oil

DOT Hazard Class: Combustible liquid

ID No.: NA1993

DOT Label: None

DOT Packaging Exceptions: 173.118a

DOT Packaging Requirements: None

MSDS Collection References: 1, 6, 7, 12, 73, 84, 101, 103, 126, 127, 132, 133, 136, 143, 146

Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** AC Darlington, MD; **Edited by:** JR Stuart, MS



Genium Publishing Corp.

One Genium Plaza
Schenectady, NY 12304-4690
(518) 377-8854

Material Safety Data Sheet Collection

2, 3, 7, 8-Tetrachlorodibenzo-*p*-dioxin
(TCDD)

MSDS No. 906

Date of Preparation: 6/94

Section 1 - Chemical Product and Company Identification

44

Product/Chemical Name: 2, 3, 7, 8-Tetrachlorodibenzo-*p*-dioxin (TCDD)

Chemical Formula: C₁₂H₄Cl₄O₂

CAS No.: 1746-01-6

Synonyms: dioxin; dioxine; NCI-C03714; tetrachlorodibenzodioxin; 2, 3, 7, 8-tetrachlorodibenzo(b, e)(1, 4)dioxin; 2, 3, 7, 8-tetrachlorodibenzo-1, 4-dioxin; TCDBD; TCDD; 2, 3, 7, 8-TCDD; tetradoxin

Derivation: TCDD is not manufactured, but is formed as a by-product of chlorobenzenes, chlorophenols, and the herbicides 2, 4, 5-trichlorophenoxyacetic acid (2, 4, 5-T) and 2-(2, 4, 5-trichlorophenoxy)propionic acid (Silvex) which are produced from 2, 4, 5-trichlorophenol (TCP). 2, 4, 5-T, commonly known as Agent Orange, was the defoliant used during the Vietnam War. TCP, 2, 4, 5-T and Silvex are no longer commercially produced in the U.S. As a chemical and toxicological standard, TCDD can be prepared by catalytic condensation of potassium 2, 4, 5-trichlorophenate. TCDD has been released to the environment during the incineration of chemical wastes including chlorinated benzenes, chlorophenols, and biphenyl ethers, from the improper disposal of certain chlorinated chemical wastes, in emissions from wood burning in the presence of chlorine, in accidental fires involving transformers containing PCBs, and from the use of the herbicides 2, 4, 5-T and Silvex.

General Use: TCDD is an extremely toxic, unwanted by-product and essentially has no beneficial uses. It may be used as a research chemical.

Vendors: Consult the latest *Chemical Week Buyers' Guide*. (73)

Section 2 - Composition / Information on Ingredients

2, 3, 7, 8-Tetrachlorodibenzo-*p*-dioxin, ca 100 %wt. TCDD normally persists as a contaminant in TCP in variable amounts (0.07-6.2 mg/kg). Consequently, the concentrations of TCDD in different batches of Agent Orange varied greatly with an average concentration of about 2 ppm.

OSHA PEL*
None established

NIOSH REL
Carcinogen, lowest feasible
concentration.

DFG (Germany) MAK
None established

ACGIH TLV
None established

* A preliminary occupational exposure limit of 0.2 ng/m³ (200 pg/m³) is recommended. It provides an ample margin of safety to prevent chloracne and takes into consideration the chronic effects of animal studies and accidental human exposure. [Leung HW et al; *American Industrial Hygiene Association Journal*, 49 (9): 466-74 b(1988)]

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

TCDD is a colorless, crystalline solid at room temperature. It is highly toxic and a potential human carcinogen. Exposure to TCDD-contaminated materials may cause a severe and disabling acne-like rash that may persist for years (chloracne), metabolic disorders, and nervous system and liver damage. In animals, TCDD causes teratogenesis, tumorigenesis, and immunological dysfunction. Findings in humans are inconclusive, but human toxicology is under continuing investigation. Workers may be exposed to TCDD from residues from prior production or use of 2, 4, 5-T or Silvex, waste materials contaminated by TCDD, or contamination resulting from transformer fires. Take every precaution to avoid any exposure to TCDD.

Potential Health Effects

Primary Entry Routes: Inhalation (dust),* skin contact, ingestion.

Target Organs: Skin, liver, and nervous system.

Acute Effects

Inhalation: Shortness of breath, headaches, fatigue, severe muscle pains, weakness, and digestive disturbance.

Most symptoms develop slowly, over many days.

Eye: Conjunctivitis and chemical burns.

Skin: Chemical burns. In most cases, chloracne appears within 2 to 4 weeks after initial exposure. It consists of blackheads with small, pale-yellow cysts. In severe cases, there may be papules (red spots) or even pustules (pus-filled spots). This acne-like rash appears on the cheekbones under the eyes and behind the ears in very mild cases. With increasing severity, the rest of the face and neck are affected and the outer upper arms, chest, back, abdomen, outer thighs and genitalia may be involved in varying degrees in the worst cases. In the worst cases, lesions may be active 15 or more years after the contact has ceased. Chloracne may also appear after ingestion or inhalation. Skin fragility, hirsutism (excessive growth of hair of normal or abnormal distribution), and photosensitivity may also occur.

Ingestion: Nausea, vomiting, and possible pancreatitis.

**Wilson
Risk
Scale**

R 1
I 4
S 4*
K 1

*Skin
absorption

HMIS

H 4†
F 1

R 0

†Chronic

Effects

PPE†

†Sec. 8

Carcinogenicity: The IARC, NTP, MAK, and NIOSH list TCDD as an IARC-2B (possibly carcinogenic to humans: inadequate evidence of carcinogenicity in humans but there is sufficient evidence of carcinogenicity in experimental animals), an NTP-2 (reasonably anticipated to be a carcinogen: limited evidence from studies in humans or sufficient evidence from studies in experimental animals), an MAK-A2 (unmistakably carcinogenic in animal experimentation only), and a NIOSH-X (carcinogen defined with no further categorization). OSHA does not list TCDD as a carcinogen.

Medical Conditions Aggravated by Long-Term Exposure: Skin, liver, nervous and endocrine system disorders.

Chronic Effects: Lack of energy, loss of sex drive, personality and mood changes, numbness, weakness and pain in the legs, liver damage, chloracne, and elevated blood lipids. TCDD increased the incidence of a variety of tumors in animals, but human data is inconclusive. Little is known of the human health effects (if any) as a result of long-term exposures to low concentrations.

Comments: The observed health effects from clinical or epidemiological studies of populations who were occupationally and non-occupationally exposed cannot be solely attributed to TCDD because of the concurrent exposure to 2, 4, 5-T and TCP and to other herbicides as well. There is no report of human exposure to TCDD alone.

* Vapor inhalation is unlikely because TCDD has a low vapor pressure.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin Contact: *Quickly* remove contaminated clothing. Flush with water to remove solid particles; follow with a soap and water wash of exposed areas. For reddened or blistered skin, consult a physician.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: For an acute exposure, obtain liver function tests, CBC, prothrombin time, serum lipids, and uroporphyrins. EMG may be useful in detecting subclinical neuropathy. Current analytical techniques to detect dioxins in human tissue specimens involve gas chromatography and mass spectrometry. Chloracne may respond to topical retinoic acid, and oral tetracyclines may help secondary pustular follicles. Resistant cases may require dermabrasion or acne surgery. Isotretinoin may be tried.

Special Precautions/Procedures: Emergency personnel should protect against contamination.

Section 5 - Fire-Fighting Measures

Flash Point: None reported.

Autoignition Temperature: None reported.

LEL: None reported.

UEL: None reported.

Extinguishing Media: Use dry chemical, carbon dioxide, water spray, or foam extinguisher.

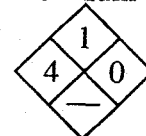
Unusual Fire or Explosion Hazards: None reported.

Hazardous Combustion Products: Toxic fumes of chlorine.

Fire-Fighting Instructions: Do not release runoff from fire control methods to sewers or waterways.

Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode.

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Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel of spill, evacuate all unnecessary personnel, remove heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against skin and eye contact and dust inhalation.

Small Spills: Carefully collect and place in sealed containers for disposal.

Large Spills

Containment: For large spills, dike far ahead of liquid spill for later disposal. Do not release into sewers or waterways.

Cleanup: Avoid generating dust. *Do not* sweep! Provide an organized procedure of containment, collection, and disposal of contaminated solutions and residues generated during cleanup. Provide separate facilities for decontamination of large equipment. Conduct repetitive wash/rinse cycles separately, either by using different locations or by spacing in time.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120). For specific recommendations, contact your Department of Environmental Protection or your regional EPA office.

Section 7 - Handling and Storage

Handling Precautions: Handle with extreme caution. Take all the necessary precautions to avoid any exposure.

Storage Requirements: Store in tightly closed and properly labeled containers in a cool, well-ventilated area.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Isolate work areas involving TCDD or TCDD-contaminated materials.

Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations as low as possible. Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source. (103)

Administrative Controls: Consider preplacement and periodic medical examinations with emphasis on the skin, liver, nervous and endocrine systems. Regularly monitor glassware, bench tops, instruments, and tools with wipe tests (wipe with filter paper and measure amount of TCDD). **Respiratory Protection:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For situations where TCDD contamination is low (e.g., exposure to dust contaminated with low levels of TCDD), wear an air-purifying respirator until the extent and characterization of the exposure can be determined. For materials highly contaminated with TCDD, wear respirators that consist of self-contained breathing apparatus with a full facepiece operated in a pressure-demand or other positive pressure mode. An alternate method utilizes a combination Type C supplied-air respirator, with full facepiece, operated in a pressure-demand mode and equipped with auxiliary positive pressure self-contained air supply. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. **Warning!** Air-purifying respirators do not protect workers in oxygen-deficient atmospheres. If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Protective Clothing/Equipment:** Consider disposable clothing due to the uncertainty of adequate decontamination. Wear protective clothing consisting of both outer (zippered coverall with attached hood and draw string or elastic sleeves, gloves and closure boots) and inner (cotton overalls, undershirts, undershorts, gloves, and socks) garments. For dust or particulate exposure, wear coveralls of a non-woven fabric such as Tyvek or spun bonded polyethylene. For exposure to liquids, wear coveralls, gloves, and boots made of chemically resistant materials such as Saranax coated Tyvek or butyl, nitrile, or neoprene rubber. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area. **Contaminated Equipment:** Shower and change clothes after potential exposures or at the end of the work day. Separate contaminated work clothes from street clothes. Launder before reuse. Place disposable clothing in marked and approved containers for disposal. Remove this material from your shoes and clean personal protective equipment. To prevent cross-contact, provide segregated decontamination locations with separate, controlled, and well-marked entry/exit routes and locations. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Solid

Appearance and Odor: Colorless needles

Water Solubility: 19.3 ng/L

Other Solubilities: *o*-dichlorobenzene (1.4 g/L); chlorobenzene (0.72 g/L); benzene (0.57 g/L); chloroform (0.37 g/L); acetone (0.11 g/L); *n*-octanol (0.05 g/L); methanol (0.01 g/L); lard oil (0.04 g/L)

Vapor Pressure: 7.4×10^{-10} mm Hg at 77 °F (25 °C)

Formula Weight: 322

Melting Point: 581-583 °F (305-306 °C)

Octanol/Water Partition Coefficient: log Kow=7.02

Henry's Law Constant: 1.62×10^{-5} atm m³/mole at 25 °C (estimated)

Section 10 - Stability and Reactivity

Stability: TCDD is relatively stable toward heat, acids, and alkalis. It is changed chemically when exposed in isooctane or *n*-octanol to UV light. **Polymerization:** Hazardous polymerization cannot occur. **Chemical Incompatibilities:** None reported. **Conditions to Avoid:** Avoid heat and ignition sources. **Hazardous Decomposition Products:** Thermal oxidative decomposition of TCDD can produce toxic fumes of chlorine. Decomposition begins at 932 °F (500 °C) and complete decomposition occurs within 21 sec at 1472 °F (800 °C).

Section 11- Toxicological Information

Toxicity Data:*

Eye Effects:

Rabbit, eye: 2 mg caused moderate irritation.

Acute Effects:

Human, skin, TD_{Lo}: 107 µg/kg produced dermatitis and allergic reaction.

Mammal, oral, LD₅₀: 4200 ng/kg produced changes of the liver, kidney, ureter, bladder, and spleen.

Rat, oral, LD₅₀: 20 µg/kg

Reproductive Effects:

Monkey, oral, TD_{Lo}: 92 ng/kg (46 weeks prior to mating, on each day during gestation, and for 17 weeks following birth) caused effects on the newborn (behavioral; delayed effects).

Genetic Effects (continued):

Human cell: 100 pmol/L caused unscheduled DNA synthesis.

Human cell: 10 nmol/L caused DNA inhibition.

Tumorigenic Effects:

Rat, oral: 52 µg/kg/2 yr (intermittent) caused liver and thyroid tumors.

Rat, oral: 27 µg/kg/65 weeks (continuous) caused liver and kidney tumors.

Multiple Dose:

Rat, oral: 6500 ng/kg/13 weeks (intermittent) caused changes in liver and thymus weight and pigmented or nucleated red blood cells.

Mouse, skin: 97 µg/kg/13 weeks (intermittent) caused diffuse hepatitis (hepatocellular necrosis); changes in spleen; and death.

* See NIOSH, RTECS (HP3500000), for additional toxicity data.

Section 12 - Ecological Information

Environmental Transport: Bioconcentration will occur in aquatic organisms. Due to TCDD's low solubility in water and lipids as well as its low partition coefficient in lipids, TCDD is not likely to accumulate in as many biological systems as DDT.

Environmental Degradation: When released to the atmosphere, gas-phase TCDD is degraded by reaction with hydroxyl radicals and direct photolysis (half-life = 8.3 days). Particulate-phase TCDD may be physically removed from air by wet and dry deposition. TCDD may be transported long distances through the atmosphere with surface water sediments being an ultimate environmental sink of airborne particulates. TCDD will absorb to sediment and limit the overall rate by which TCDD is removed from water. TCDD near the water's surface may experience significant photodegradation. 1.5 yr is the persistence half-life of TCDD in lakes. TCDD is generally resistant to biodegradation. Photodegradation on terrestrial surfaces may be an important transformation process. During warm conditions, volatilization from soil surfaces may be a major removal mechanism. Volatilization of TCDD from dry soil surfaces is likely to be faster than from wet soil surfaces. TCDD that has been mixed into soil depths beneath the upper surface boundary will volatilize extremely slowly. On soil surfaces, persistence half-life of TCDD on soil surfaces varies from less than 1 yr to 3 yr. Half-lives in soil interiors may be as long as 12 yr.

Soil Absorption/Mobility: TCDD is immobile in soil and is not expected to leach. Lateral movement due to surface erosion may occur.

Section 13 - Disposal Considerations

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information**DOT Transportation Data (49 CFR 172.101):**

Shipping Name: Environmentally hazardous substances, solid, n.o.s.*

Shipping Symbols: —

Hazard Class: 9

ID No.: UN3077

Packing Group: III

Label: Class 9

Special Provisions (172.102): 8, B54, N50

Packaging Authorizations

a) Exceptions: 173.155

b) Non-bulk Packaging: 173.213

c) Bulk Packaging: 173.240

Quantity Limitations

a) Passenger, Aircraft, or Railcar: None

b) Cargo Aircraft Only: None

Vessel Stowage Requirements

a) Vessel Stowage: A

b) Other: —

* If it is in a quantity, in one package which equals or exceeds the RQ of 1 lb (0.454 kg).

Section 15 - Regulatory Information

EPA Regulations: RCRA Hazardous Waste (40 CFR 261.33): Not listed

Listed as a CERCLA Hazardous Substance (40 CFR 302.4) specific per CWA, Sec. 307(a)

CERCLA Reportable Quantity (RQ), 1 lb (0.454 kg)

SARA Toxic Chemical (40 CFR 372.65): Not listed

SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed

OSHA Regulations: Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A): Not listed

Section 16 - Other Information

References: 73, 103, 124, 132, 136, 139, 184, 187, 189, 190, 193

Prepared By MJ Wurth, BS **Industrial Hygiene Review** PA Roy, MPH, CIH **Medical Review** T Thoburn, MD, MPH

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Genium Publishing Corporation

One Genium Plaza
Schenectady, NY 12304-4690 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 467
Automotive Gasoline, Lead-free

Issued: 10/81

Revision: A, 9/91

35

Section 1. Material Identification

Automotive Gasoline, Lead-free, Description: A mixture of volatile hydrocarbons composed mainly of branched-chain paraffins, cycloparaffins, olefins, naphthenes, and aromatics. In general, gasoline is produced from petroleum, shale oil, Athabasca tar sands, and coal. Motor gasolines are made chiefly by cracking processes, which convert heavier petroleum fractions into more volatile fractions by thermal or catalytic decomposition. Widely used as fuel in internal combustion engines of the spark-ignited, reciprocating type. Automotive gasoline has an octane number of approximately 90. A high content of aromatic hydrocarbons and a consequent high toxicity are also associated with a high octane rating. Some gasolines sold in the US contain a minor proportion of tetraethyllead, which is added in concentrations not exceeding 3 ml per gallon to prevent engine "knock." However, methyl-tert-butyl ether (MTBE) has almost completely replaced tetraethyllead.

Other Designations: CAS No. 8006-61-9, benzin, gasoline, gasolene, motor spirits, natural gasoline, petrol.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*⁽⁷³⁾ for a suppliers list.

R 1
I 2
S 2*
K 4
* Skin absorption

NFPA
3
1 0
HMIS
H 2
F 3
R 1
PPG†
† Sec. 8

Cautions: Inhalation of automotive gasoline vapors can cause intense burning in throat and lungs, central nervous system (CNS) depression, and possible fatal pulmonary edema. Gasoline is a dangerous fire and explosion hazard when exposed to heat and flames.

Section 2. Ingredients and Occupational Exposure Limits

Automotive gasoline, lead-free*

1990 OSHA PELs

8-hr TWA: 300 ppm, 900 mg/m³

15-min STEL: 500 ppm, 1500 mg/m³

1990-91 ACGIH TLVs

TWA: 300 ppm, 890 mg/m³

STEL: 500 ppm, 1480 mg/m³

1990 NIOSH REL

None established

1985-86 Toxicity Data*

Man, inhalation, TC_{Lo}: 900 ppm/1 hr; toxic effects include sense organs and special senses (conjunctiva irritation), behavioral (hallucinations, distorted perceptions), lungs, thorax, or respiration (cough)

Human, eye: 140 ppm/8 hr; toxic effects include mild irritation

Rat, inhalation, LC₅₀: 300 g/m³/5 min

* A typical modern gasoline composition is 80% paraffins, 14% aromatics, and 6% olefins. The mean benzene content is approximately 1%. Other additives include sulfur, phosphorus, and MTBE.

† See NIOSH, RTECS (LX3300000), for additional toxicity data.

Section 3. Physical Data

Boiling Point: Initially, 102 °F (39 °C); after 10% distilled, 140 °F (60 °C); after 50% distilled, 230 °F (110 °C); after 90% distilled, 338 °F (170 °C); final boiling point, 399 °F (204 °C)

Vapor Density (air = 1): 3.0 to 4.0

Density/Specific Gravity: 0.72 to 0.76 at 60 °F (15.6 °C)

Water Solubility: Insoluble

Appearance and Odor: A clear (gasoline may be colored with dye), mobile liquid with a characteristic odor recognizable at about 10 ppm in air.

Section 4. Fire and Explosion Data

Flash Point: -45 °F (-43 °C)

Autoignition Temperature: 536 to 853 °F (280 to 456 °C)

LEL: 1.3% v/v

UEL: 6.0% v/v

Extinguishing Media: Use dry chemical, carbon dioxide, or alcohol foam as extinguishing media. Use of water may be ineffective to extinguish fire, but use water spray to knock down vapors and to cool fire-exposed drums and tanks to prevent pressure rupture. Do not use a solid stream of water since it may spread the fuel.

Unusual Fire or Explosion Hazards: Automobile gasoline is an OSHA Class IB flammable liquid and a dangerous fire and explosion hazard when exposed to heat and flames. Vapors can flow to an ignition source and flash-back. Automobile gasoline can also react violently with oxidizing agents.

Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode, and full protective clothing. When the fire is extinguished, use nonsparking tools for cleanup. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Automotive gasoline is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Automotive gasoline can react with oxidizing materials such as peroxides, nitric acid, and perchlorates.

Conditions to Avoid: Avoid heat and ignition sources.

Hazardous Products of Decomposition: Thermal oxidative decomposition of automotive gasoline can produce oxides of carbon and partially oxidized hydrocarbons.

Section 6. Health Hazard Data

Carcinogenicity: In 1990 reports, the IARC list gasoline as a possible human carcinogen (Group 2B). Although the IARC has assigned an overall evaluation to gasoline, it has not assigned an overall evaluation to specific substances within this group (inadequate human evidence).

Summary of Risks: Gasoline vapors are considered moderately poisonous. Vapor inhalation can cause central nervous system (CNS) depression and mucous membrane and respiratory tract irritation. Brief inhalations of high concentrations can cause a fatal pulmonary edema. Reported responses to gasoline vapor concentrations are: 160 to 270 ppm causes eye and throat irritation in several hours; 500 to 900 ppm causes eye, nose and throat irritation, and dizziness in 1 hr; and 2000 ppm produces mild anesthesia in 30 min. Higher concentrations are intoxicating in 4 to 10 minutes. If large areas of skin are exposed to gasoline, toxic amounts may be absorbed. Repeated or prolonged skin exposure causes dermatitis. Certain individuals may develop hypersensitivity. Ingestion can cause CNS depression. Pulmonary aspiration after ingestion can cause severe pneumonitis. In adults, ingestion of 20 to 50 g gasoline may produce severe symptoms of poisoning.

Medical Conditions Aggravated by Long-Term Exposure: None reported.

Target Organs: Skin, eye, respiratory and central nervous systems.

Primary Entry Routes: Inhalation, ingestion, skin contact.

Acute Effects: Acute inhalation produces intense nose, throat, and lung irritation; headaches; blurred vision; conjunctivitis; flushing of the face; mental confusion; staggering gait; slurred speech; and unconsciousness, sometimes with convulsions. Ingestion causes inebriation (drunkenness), vomiting, dizziness, fever, drowsiness, confusion, and cyanosis (a blue to dark purplish coloration of skin and mucous membrane caused by lack of oxygen). Aspiration causes choking, cough, shortness of breath, increased rate of respiration, excessively rapid heartbeat, fever, bronchitis, and pneumonitis. Other symptoms following acute exposure include acute hemorrhage of the pancreas, fatty degeneration of the liver and kidneys, and passive congestion of spleen.

Chronic Effects: Chronic inhalation results in appetite loss, nausea, weight loss, insomnia, and unusual sensitivity (hyperesthesia) of the distal extremities followed by motor weakness, muscular degeneration, and diminished tendon reflexes and coordination. Repeated skin exposure can cause blistering, drying, and lesions.

FIRST AID

Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin: Quickly remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, *do not induce vomiting* due to aspiration hazard. Give conscious victim a mixture of 2 tablespoons of activated charcoal mixed in 8 oz of water to drink. Consult a physician immediately.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, remove heat and ignition sources, and provide maximum explosion-proof ventilation. Cleanup personnel should protect against vapor inhalation and liquid contact. Use nonsparking tools. Take up small spills with sand or other noncombustible adsorbent. Dike storage areas to control leaks and spills. Follow applicable OSHA regulations (29 CFR 1910.120).

Aquatic Toxicity: Bluegill, freshwater, LC₅₀ 8 ppm/96 hr.

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

RCRA Hazardous Waste (40 CFR 261.21): Characteristic of ignitability

CERCLA Hazardous Substance (40 CFR 302.4): Not listed

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

SARA Toxic Chemical (40 CFR 372.65): Not listed

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Since contact lens use in industry is controversial, establish your own policy.

Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. There are no specific NIOSH recommendations. However, for vapor concentrations not immediately dangerous to life or health, use chemical cartridge respirator equipped with organic vapor cartridge(s), or a supplied-air respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Materials such as neoprene or polyvinyl alcohol provide excellent/good resistance for protective clothing. Note: Resistance of specific materials can vary from product to product.

Ventilation: Provide general and local explosion-proof exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.⁽¹⁰³⁾

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in closed containers in a cool, dry, well-ventilated area away from heat and ignition sources and strong oxidizing agents. Protect containers from physical damage. Avoid direct sunlight. Storage must meet requirements of OSHA Class IB liquid. Outside or detached storage preferred.

Engineering Controls: Avoid vapor inhalation and skin or eye contact. Consider a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Indoor use of this material requires explosion-proof exhaust ventilation to remove vapors. Only use gasoline as a fuel source due to its volatility and flammable/explosive nature. Practice good personal hygiene and housekeeping procedures. Wear clean work clothing daily.

DOT Shipping Name: Gasoline (including casing-head and natural)

DOT Hazard Class: Flammable liquid

ID No.: UN1203

DOT Label: Flammable liquid

DOT Packaging Exceptions: 173.118

DOT Packaging Requirements: 173.119

IMO Shipping Name: Gasoline

IMO Hazard Class: 3.1

ID No.: UN1203

IMO Label: Flammable liquid

IMDG Packaging Group: II

MSDS Collection References: 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 138, 140, 143, 146, 153, 159

Prepared by: M Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD; **Edited by:** JR Stuart, MS



Genium Publishing Corporation
One Genium Plaza
Schenectady, NY 12304-4690 USA
(518) 377-8854

Material Safety Data Sheets Collection

Sheet No. 713
Lead (Inorganic)

Issued: 8/90

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Section 1. Material Identification

Lead (Inorganic) (Pb) Description: Exists widely throughout the world in a number of ores. Its main commercial source is galena (lead sulphide). Lead mineral is separated from crude ores by blast-furnace smelting, dressing, or electrolytic refining. Lead is used mostly in manufacturing storage batteries. Other uses are in manufacturing tetraethyllead and both organic and inorganic lead compounds in ceramics, plastics, and electronic devices; in producing ammunition, solder, cable covering, sheet lead, and other metal products (brass, pipes, caulking); in metallurgy; in weights and as ballast; as a chemical intermediate for lead alkyls and pigments; as a construction material for the tank linings, piping, and equipment used to handle the corrosive gases and liquids used in sulfuric acid manufacturing, petroleum refining, halogenation, sulfonation, extraction, and condensation; and for x-ray and atomic radiation protection.

Other Designations: CAS No. 7439-92-1, lead oxide; lead salts, inorganic; metallic lead; plumbum.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*⁽⁷³⁾ for a suppliers list.

Cautions: *Inorganic lead is a potent systemic poison.* Organic lead (for example, tetraethyl lead) has severe, but different, health effects. * Sec. 8 Occupational lead poisoning is due to inhalation of dust and fumes. Major affected organ systems are the nervous, blood, and reproductive systems, and kidneys. Health impairment or disease may result from a severe acute short- or long-term exposure.

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Section 2. Ingredients and Occupational Exposure Limits

Lead (inorganic) fumes and dusts, as Pb, ca 100%

1989 OSHA PELs (Lead, inorganic compounds)

8-hr TWA: 50 µg/m³

Action Level TWA*: 30 µg/m³

1989-90 ACGIH TLV (Lead, inorganic, fumes and dusts)

TLV-TWA: 150 µg/m³

1985-86 Toxicity Data†

Human, inhalation, TC_{Lo}: 10 µg/m³ affects gastrointestinal tract and liver

Human, oral, TD_{Lo}: 450 mg/kg ingested over 6 yr affects peripheral and central nervous systems

Rat, oral, TD_{Lo}: 790 mg/kg affects multigeneration reproduction

29 CFR 1910.1025 Lead Standard

Blood Lead Level: 40 µg/100 g

1988 NIOSH REL

10-hr TWA: <100 µg/m³

* Action level applies to employee exposure without regard to respirator use.

† See NIOSH, RTECS (OF7525000), for additional mutative, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 3164 °F (1740 °C)

Melting Point: 621.3 °F (327.4 °C)

Vapor Pressure: 1.77 mm Hg at 1832 °F (1000 °C)

Viscosity: 3.2 cp at 621.3 °F (327.4 °C)

Appearance and Odor: Bluish-white, silvery, gray, very soft metal.

Molecular Weight: 207.20

Specific Gravity (20 °C/4 °C): 11.34

Water Solubility: Relatively insoluble in hot or cold water*

* Lead dissolves more easily at a low pH.

Section 4. Fire and Explosion Data

Flash Point: None reported

Autoignition Temperature: None reported

LEL: None reported

UEL: None reported

Extinguishing Media: Use dry chemical, carbon dioxide, water spray, or foam to extinguish fire.

Unusual Fire or Explosion Hazards: Flammable and moderately explosive in the form of dust when exposed to heat or flame.

Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective equipment. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Lead is stable at room temperature in closed containers under normal storage and handling conditions. It tarnishes on exposure to air. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Mixtures of hydrogen peroxide + trioxane explode on contact with lead. Lead is incompatible with sodium azide, zirconium, disodium acetylide, and oxidants. A violent reaction on ignition may occur with concentrated hydrogen peroxide, chlorine trifluoride, sodium acetylide (with powdered lead), ammonium nitrate (below 200 °C with powdered lead). Lead is attacked by pure water and weak organic acids in the presence of oxygen. Lead is resistant to tap water, hydrofluoric acid, brine, and solvents.

Conditions to Avoid: Rubber gloves containing lead may ignite in nitric acid.

Hazardous Products of Decomposition: Thermal oxidative decomposition of lead can produce highly toxic fumes of lead.

Section 6. Health Hazard Data

Carcinogenicity: Although the NTP and OSHA do not list lead as a carcinogen, the IARC lists it as probably carcinogenic to humans, but having (usually) no human evidence. However, the literature reports instances of lead-induced neoplasms, both benign and malignant, of the kidney and other organs in laboratory rodents. Excessive exposure to lead has resulted in neurologic disorders in infants. Experimental studies show lead has reproductive and teratogenic effects in laboratory animals. Human male and female reproductive effects are also documented.

Summary of Risks: Lead is a potent, systemic poison that affect a variety of organ systems, including the nervous system, kidneys, reproductive system, blood formation, and gastrointestinal (GI) system. The most important way lead enters the body is through inhalation, but it can also be ingested when lead dust or unwashed hands contaminate food, drink, or cigarettes. Much of ingested lead passes through feces without absorption into the body. Adults may absorb only 5 to 15% of ingested lead; children may absorb a much larger fraction. Once in the body, lead enters the bloodstream and circulates to various organs. Lead concentrates and remains in bone for many years. The amount of lead the body stores increases as exposure continues, with possibly cumulative effects. Depending on the dose entering the body, lead can be deadly within several days or affect health after many years. Very high doses can cause brain damage (encephalopathy).

Medical Conditions Aggravated by Exposure: Lead may aggravate nervous system disorders (e.g., epilepsy, neuropathies), kidney diseases, high blood pressure (hypertension), infertility, and anemia. Lead-induced anemia and its effect on blood pressure can aggravate cardiovascular disease.

Continue on next page

Section 6. Health Hazard Data, continued

Target Organs: Blood, central and peripheral nervous systems, kidneys, and gastrointestinal (GI) tract.

Primary Entry Routes: Inhalation, ingestion.

Acute Effects: An acute, short-term dose of lead could cause acute encephalopathy with seizures, coma, and death. However, short-term exposures of this magnitude are rare. Reversible kidney damage can occur from acute exposure, as well as anemia.

Chronic Effects: Symptoms of chronic long-term overexposure include appetite loss, nausea, metallic taste in the mouth, lead line on gingiva (gum) tissue, constipation, anxiety, anemia, pallor of the face and the eye grounds, excessive tiredness, weakness, insomnia, headache, nervous irritability, fine tremors, numbness, muscle and joint pain, and colic accompanied by severe abdominal pain. Paralysis of wrist and, less often, ankle extensor muscles may occur after years of increased lead absorption. Kidney disease may also result from chronic overexposure, but few, if any, symptoms appear until severe kidney damage has occurred. Reproductive damage is characterized by decreased sex drive, impotence, and sterility in men; and decreased fertility, abnormal menstrual cycles, and miscarriages in women. Unborn children may suffer neurologic damage or developmental problems due to excessive lead exposure in pregnant women. Lead poisoning's severest result is encephalopathy manifested by severe headache, convulsions, coma, delirium, and possibly death.

FIRST AID

Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin: Quickly remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Consult a physician if any health complaints develop.

Inhalation: Remove exposed person to fresh air and support breathing as needed. Consult a physician.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If large amounts of lead were ingested, induce vomiting with

Ipecac syrup. Consult a physician immediately.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Physician's Note: For diagnosis, obtain blood pressure, blood lead level (PbB), zinc protoporphyrin (ZPP), complete blood count for microcytic anemia and basophilic stippling, urinalysis, and blood urea nitrogen (BUN) of creatinine. Examine peripheral motor neuropathy, pallor, and gingival lead line. Use Ca-EDTA to treat poison, but *never* chelate prophylactically. Consult an occupational physician or toxicologist.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel and evacuate all unnecessary personnel immediately. Cleanup personnel should protect against inhalation of dusts or fume and contact with skin or eyes. Avoid creating dusty conditions. Water sprays may be used in large quantities to prevent the formation of dust. Cleanup methods such as vacuuming (with an appropriate filter) or wet mopping minimizes dust dispersion. Scoop the spilled material into closed containers for disposal or reclamation. Follow applicable OSHA regulations (29 CFR 1910.120).

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.33, Appendix II—EP Toxicity Test Procedures)

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* per Clean Water Act, Sec. 307(a)]

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. **Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.**

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact. Protective clothing made of man-made fibers and lacking turn-ups, pleats, or pockets retain less dust from lead.

Ventilation: Provide general and local ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.⁽¹⁰³⁾

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially washing hands before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, dry, well-ventilated area away from all incompatible materials, direct sunlight, and heat and ignition sources.

Engineering Controls: Educate worker about lead's hazards. Follow and inform employees of the lead standard (29 CFR 1910.1025). Avoid inhalation of lead dust and fumes and ingestion of lead. Use only with appropriate personal protective gear and adequate ventilation. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Avoid creating dusty conditions. Segregate and launder contaminated clothing. Take precautions to protect laundry personnel. Practice good personal hygiene and housekeeping procedures. For a variety of reasons, the lead concentration in workroom air may not correlate with the blood lead levels in individuals.

Other Precautions: Provide preplacement and periodic medical examinations which emphasize blood, nervous system, gastrointestinal tract, and kidneys, including a complete blood count and urinalysis. Receive a complete history including previous surgeries and hospitalization, allergies, smoking history, alcohol consumption, proprietary drug intake, and occupational and nonoccupational lead exposure. Maintain records for medical surveillance, airborne exposure monitoring, employee complaints, and physician's written opinions for at least 40 years or duration of employment plus 20 years. Measurement of blood lead level (PbB) and zinc protoporphyrin (ZPP) are useful indicators of your body's lead absorption level. Maintain worker PbBs at or below 40 µg/100 g of whole blood. To minimize adverse reproductive health effects to parents and developing fetus, maintain the PbBs of workers intending to have children below 30 µg/100 g. Elevated PbBs increase your risk of disease, and the longer you have elevated PbBs, the greater your chance of substantial permanent damage.

Transportation Data (49 CFR 172.102)

IMO Shipping Name: Lead compounds, soluble, n.o.s.

IMO Hazard Class: 6.1

ID No.: UN2291

IMO Label: St. Andrews Cross (X, Stow away from foodstuffs)

IMDG Packaging Group: III

MSDS Collection References: 26, 38, 73, 84, 85, 88, 89, 90, 100, 101, 103, 109, 124, 126, 132, 133, 134, 136, 138, 139, 142, 143

Prepared by: MJ Allison, BS; Industrial Hygiene Review: DJ Wilson, CIH; Medical Review: MJ Upfal, MD, MPH; Edited by: JR Stuart, MS



Genium Publishing Corporation

One Genium Plaza
Schenectady, NY 12304-4690 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 148
Manganese Metal/Powder

Issued: 9/85

Revision: A, 11/89

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Section 1. Material Identification

Manganese Metal/Powder Description: A metallic element associated with iron ores such as pyrolusite, manganite, psilomelane, and rhodochrosite found mainly in open-hearth slags. Manganese is obtained from the reduction of the oxide with aluminum or carbon. Pure manganese is obtained electrically from chloride or sulfate solution. Used in ferroalloys (steel manufacture); for wagon buffers, rock crushers, railway points and crossings; as a purifying and scavenging agent in metal production; in the manufacture of aluminum by Toth process, dry-cell batteries, glass, welding rods, inks, rubber and wood preservatives, paints, and ceramics; high-purity salt for various chemical uses.

Other Designations: Manganese; colloidal manganese; magnacat; Mn; CAS No. 7439-96-5.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.

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* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Manganese, ca 100%

OSHA PEL

Ceiling limit: 5 mg/m³ (manganese compounds, as Mn)

ACGIH TLVs, 1988-89

TLV-TWA: 5 mg/m³ (dust and compounds)

TLV-TWA: 1 mg/m³ (fume)

STEL: 3 mg/m³ (fume)

NIOSH REL, 1987

Ceiling limit: 5 mg/m³ (manganese and compounds, as Mn)

Toxicity Data*

Human, inhalation, TC_{Lo}: 2300 µg/m³

* See NIOSH, RTECS (OO9275000), for additional data with references to mutagenic and tumorigenic effects.

Section 3. Physical Data

Boiling Point: 3803 °F (2095 °C)*

Melting Point: 2300 °F (1260 °C)

Vapor Pressure: 1 mm Hg at 2358 °F (1292 °C)

Atomic Weight: 54.94

Specific Gravity (H₂O = 1 at 39 °F (4 °C)): 7.20

Water Solubility: Impure Mn decomposes slowly

Appearance and Odor: Reddish-grey or silvery powder or metal. No odor.

* Other sources (Genium refs. 7, 89, and 126) give 3807 °F (2097 °C), 3564 °F (1962 °C), and 3452 °F (1900 °C) boiling points, respectively.

Section 4. Fire and Explosion Data

Flash Point: None reported

Autoignition Temperature: *

LEL: *

UEL: None reported

Extinguishing Media: Use dry chemical extinguishing agent designed for metal fires.

Unusual Fire or Explosion Hazards: Manganese dust or powder is flammable and moderately explosive when exposed to flame or heated in carbon dioxide. Mixtures of manganese dust and aluminum dust may explode in air. Ammonium nitrate and manganese may explode when heated. Flammable hydrogen gas is generated under certain conditions (Sec. 5).

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

* Manganese metal/powder can present a dust explosion hazard under favoring conditions of particle size and airborne dust dispersion. The minimum explosive concentration of Mn is 0.125 oz/ft³, with a minimum ignition temperature of 842 °F (450 °C). Oxygen concentrations of less than 15% prevent ignition.

Section 5. Reactivity Data

Stability/Polymerization: Manganese is stable at room temperature in closed containers. Hazardous polymerization cannot occur.

Chemical Incompatibilities: The powdered metal ignites on contact with hydrogen peroxide, bromine pentafluoride, fluorine, chlorine and heat, and sulfur dioxide and heat. It reacts violently with oxidants and nitrogen dioxide (NO₂), and incandescently with nitric acid, phosphorus, and nitryl fluoride. Manganese reacts slowly with water at 21 °F (100 °C), forming hydrogen gas (flammable). Contact with acids (including dilute acids) readily dissolves Mn, with the evolution of hydrogen. Hot, concentrated potassium and sodium hydroxides also dissolve Mn, forming hydrogen and manganese hydroxide.

Hazardous Products of Decomposition: Thermal oxidative decomposition of manganese can produce manganese oxides.

Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists manganese as a carcinogen.

Summary of Risks: Although an essential element for man, manganese is also toxic to humans in several ways. Acute or chronic manganese poisoning can result from excessive inhalation or ingestion. The immune system reacts to acute exposures with "metal fume fever," characterized by: fever, chills, nausea, weakness, body aches, frontal headache, occasional blurred vision, low back pain, muscle cramping, shallow respiration, throat dryness and irritation, a dry cough, a sweet or metallic taste, and chest tightness occurring over several hours. Progressive and permanent injury can result from chronic, untreated Mn poisoning. Its most notable effects are the neurological disorders caused by its ability to inhibit the chemical transmission of electrical impulses in the central nervous system. The lungs may become inflamed (manganese pneumonitis), as reported in workers exposed to manganese ores and compounds. Sufficient evidence proves that in several species, manganese is embryolethal at toxic doses. Impotence is a common symptom in grossly contaminated men.

Medical Conditions Aggravated by Long-Term Exposure: Degenerative brain changes, muscle weakness, change in motor activity.

Target Organs: Central nervous system (CNS), respiratory system, kidneys, blood.

Primary Entry: Inhalation, ingestion.

Acute Effects: High-concentration exposures may cause metal fume fever, with its onset occurring over several hours. Inhalation of large concentrations may cause manganese pneumonitis. This material is a skin and eye irritant leading to dermatitis, conjunctivitis, and corneal damage.

Chronic Effects: Exposure to manganese fume over 6 months to 2 years may harm the central nervous system, with symptoms progressing from headache, restless sleep or sleepiness, personality changes, irritability and inappropriate laughing or crying to visual hallucinations, double vision, uncontrolled impulse behavior, euphoria, and to abnormal reaction to painful stimuli, excess salivation, trembling in the extremities and head, impaired walking, and other signs similar to Parkinson's disease.

FIRST AID

Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.

Skin: After rinsing affected area with flooding amounts of water, wash it with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that conscious person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear.

After first aid, get appropriate in-plant, paramedic, or community medical attention and support.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Remove heat and ignition sources. Ventilate spill area. Cleanup personnel should wear appropriate respiratory protective equipment. Carefully scoop spilled material, avoiding dust generation, into a suitable salvage container.

Disposal: Return scrap material to supplier or processor for recovery. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)

EPA Designations

RCRA Hazardous Waste (40 CFR 261.33): Not listed

CERCLA Hazardous Substance (40 CFR 302.4): Not listed

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: Wear a NIOSH-approved respirator where airborne concentrations exceed the ceiling limit. Fume or high-efficiency particulate filter respirators are acceptable for concentrations up to 50 mg/m³ (250 mg/m³ with full facepiece). Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.

Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact.

Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below OSHA, ACGIH, and NIOSH standards. Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103). Consider the dust explosion potential of finely divided Mn powder when designing exhaust ventilation systems and other process equipment to contain heavily dust-laden air.

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing. Remove this material from your shoes and equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in closed containers in a cool, dry, well-ventilated area away from ignition sources, acids, alkali, and other incompatible materials. Protect containers from physical damage.

Engineering Controls: Use with adequate ventilation. Avoid breathing dust and fumes. Maintain good housekeeping practices to prevent dust accumulation. Use cleanup procedures that minimize dust generation. Practice good personal hygiene. Examine exposed personnel at regular intervals with emphasis on the respiratory and central nervous systems.

Transportation Data (49 CFR 172.101, .102): Not listed

MSDS Collection References: 2, 4, 7, 8, 9, 12, 14, 20, 25, 27, 38, 44, 47, 55, 58, 81, 89, 90, 100, 124, 126

Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** Warren Silverman, MD

F5



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One Genium Plaza
Schenectady, NY 12304-4690
(518) 377-8854

Material Safety Data Sheet Collection

Mercury

MSDS No. 26

Date of Preparation: 1/77

Revision: D, 6/94

Section 1 - Chemical Product and Company Identification

44

Product/Chemical Name: Mercury

Chemical Formula: Hg

CAS No.: 7439-97-6

Synonyms: colloidal mercury, hydrargyrum, liquid silver, Quicksilver

Derivation: Obtained by roasting cinnabar (mercury sulfide) and purified by distillation, or as a by-product of gold mining.

General Use: Used in agricultural poisons, anti-fouling paint, dental amalgams, mining amalgamation (to remove gold and other metals from ore), thermometers, barometers, dry cell batteries, chlorine and caustic soda production, electrical apparatus, and as a neutron absorber in nuclear power plants.

Vendors: Consult the latest *Chemical Week Buyers' Guide*. (73)

Section 2 - Composition / Information on Ingredients

Mercury, ca 100 %wt

OSHA PEL

Ceiling: 0.1 mg/m³ (vapor and inorganic Hg)

8-hr TWA: 0.05 mg/m³ (vapor), skin; (Vacated 1989 Final Rule Limit)

ACGIH TLVs

TWA: 0.025 mg/m³ (inorganic compounds), skin

NIOSH REL

10-hr TWA: 0.05 mg/m³ (vapor), skin

DFG (Germany) MAK

TWA: 0.01 ppm (0.1 mg/m³)

Category III: Substances with systemic effects

Onset of Effect: > 2 hr

Half-life: > shift length (strongly cumulative)

Peak Exposure Limit:

0.1 ppm (1 mg/m³), 30 min. average value, 1/shift

IDLH Level

28 mg/m³

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Mercury exists as a heavy, odorless, silver-white liquid metal. It is highly toxic by both acute and chronic exposure. Exposure can cause corrosion of the eyes, skin, and respiratory tract and may result in irreversible nervous system damage. It readily forms amalgamations with most metals except iron.

Potential Health Effects

Primary Entry Routes: Inhalation, eye and skin contact/absorption.

Target Organs: Central nervous system, eyes, skin, respiratory system, liver, kidneys.

Acute Effects

Inhalation: Exposure to high vapor concentrations can cause severe respiratory damage. Other symptoms include wakefulness, muscle weakness, anorexia, headache, ringing in the ear, headache, diarrhea, liver changes, fever, gingivitis, chest pain, difficulty breathing, cough, inflammation of the mouth (stomatitis), salivation, bronchitis, and pneumonitis. Acrodynia (pink or Swifts disease), characterized by redness and peeling of the skin on the toes and fingers, was commonly seen in children in the 1950s and is still *infrequently* seen in workers.

Eye: Irritation and corrosion.

Skin: Skin can become severely irritated if allowed to remain in contact with mercury. Skin absorption will occur at 2.2% of the rate of absorption through the lungs.

Ingestion: Mercury generally passes through the digestive tract uneventfully. However, large amounts may get caught up in the intestine and require surgical removal. If an abscess or other perforation is present along the digestive tract, absorption into the blood stream with subsequent mercury poisoning is possible.

Carcinogenicity: IARC, NTP, and OSHA do not list mercury as a carcinogen.

Medical Conditions Aggravated by Long-Term Exposure: Central nervous system disorders.

Chronic Effects: Chronic exposure appears more common than acute and is primarily associated with central nervous system damage which can be permanent (ex. paresthesia of the hands, lips, feet). Early signs of toxicity include weakness, fatigue, anorexia, weight loss, and gastrointestinal disturbances. If exposure levels are high, characteristic tremors of the fingers, eyelids, and lips occur with progression to generalized tremors of the entire body. Psychic disorders are noticeable and characterized by behavior and personality changes, increased excitability, memory loss, insomnia, and depression. In severe cases, delirium and hallucinations may occur. Kidney damage is observed with oliguria (decreased urine output) progressing to anuria (urine cessation) and may require dialysis. The cornea and lens of the eyes may take on a brownish discoloration and the extraocular muscles may be damaged. This syndrome has been termed *Asthenic-Vegetative Syndrome* or *Micromercurialism*. Chronic symptoms occur increasingly with exposures to 0.1 mg/m³ or higher. **Mutation:** Aneuploidy and other chromosomal aberrations

Wilson Risk Scale

R 1
I 4
S 2*
K 1

*Skin
absorption

HMIS

H 4*
F 0
R 0

*Chronic
effects

PPE†
†Sec. 8

have been observed in the lymphocytes from whole blood cultures in workers exposed to mercury. *Reproductive:* Mercury has been detected in stillborn babies of women treated with mercury for syphilis. In a study of six men acutely exposed (occupationally) to mercury levels as high as 44 mg/m^3 , all suffered impaired sexual function. Repeated skin contact may cause allergic dermatitis in some individuals.

NOTE: Spilled mercury will release sufficient vapor over time to produce chronic poisoning.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water and then wash exposed area with soap. For reddened or blistered skin, consult a physician.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. In general, mercury will pass through the digestive tract uneventfully.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: BEI: blood ($15 \text{ } \mu\text{g/L}$), urine: ($35 \text{ } \mu\text{g/g}$ creatinine). Extremely high urine levels of 0.5 to 0.85 mg Hg/L are indicative of polyneuropathy. 0.4 to 22 $\mu\text{g/L}$ is reported to be the human lethal blood level. Obtain urinalysis including at a minimum: albumin, glucose, and a microscopic examination of centrifuged sediment. Use BAL or 2, 3-dimercaptosuccinic acid as chelators. *Do not* use calcium sodium EDTA because of nephrotoxicity. An electromyograph may determine extent of nerve dysfunction. It has been noted that exposure to mercury may predispose persons to development of carpal tunnel syndrome.

Section 5 - Fire-Fighting Measures

Flash Point: Nonflammable

Autoignition Temperature: Nonflammable

LEL: None reported.

UEL: None reported.

Extinguishing Media: Use agents suitable for surrounding fire.

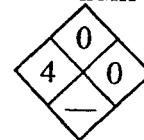
Unusual Fire or Explosion Hazards: None reported.

Hazardous Combustion Products: Toxic mercury vapor and mercuric oxide.

Fire-Fighting Instructions: Do not release runoff from fire control methods to sewers or waterways.

Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode.

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Section 6 - Accidental Release Measures

Spill /Leak Procedures: Keep a mercury spill kit readily available in areas where mercury is used. Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind.

Small and Large Spills: Follow instructions on mercury spill kit. Most kits come with an aspiration-driven vacuum trap with a mercury "sweeper" (copper or copper-plated brush). Wash spill area with a dilute calcium sulfide or nitric acid solution. If spill cannot be taken up readily, dust the top of the spill with flowers of sulfur or preferably, calcium polysulfide. This will produce a surface coating of mercury sulfide which will reduce mercury vapor dispersion into the air.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Use appropriate PPE when working with mercury. *Do not* use on porous work surfaces (wood, unsealed concrete, etc.) to prevent spills from lodging in cracks.

Storage Requirements: Store in a cool, dry, well-ventilated area away from heat and incompatibles (Sec. 10). Store on non-porous floors and wash them regularly with a dilute calcium sulfide solution. Because mercury will form amalgamations with most metals except iron, metal shelves should be painted with a sufficiently thick coating to prevent this from happening.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Wherever possible, enclose processes to prevent mercury vapor dispersion into work area.

Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source. (103)

Administrative Controls: Consider pre-placement and periodic medical exams of exposed workers with emphasis on the skin, eyes, central nervous system, liver, and kidneys.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For $\leq 0.5 \text{ mg/m}^3$, use any chemical cartridge respirator with cartridges providing protection against mercury and equipped with an ESLI (end of service life indicator), any SCBA, or any SAR (supplied-air respirator). For $\leq 1.25 \text{ mg/m}^3$, use any SAR operated in continuous-flow mode, any PAPR (powered, air-purifying respirator) with an ESLI. For $\leq 2.5 \text{ mg/m}^3$, use any SCBA or SAR with a full facepiece, any SAR with a tight-fitting facepiece and operated in continuous-flow mode, or any chemical cartridge respirator with a full facepiece, chemical

cartridges providing protection against mercury, and equipped with an ESLI. For $\leq 28 \text{ mg/m}^3$, use any SAR operated in pressure-demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA with full facepiece and operated in pressure-demand or other positive pressure mode. **Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.** If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets made of butyl rubber, nitrile rubber, fluorocarbon rubber, neoprene rubber, polyvinyl chloride, chlorinated polyethylene, or polycarbonate to prevent prolonged or repeated skin contact. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.

Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.

Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove this material from your shoes and clean personal protective equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Liquid metal

Appearance and Odor: Silvery-white, odorless

Vapor Pressure: 0.0018 mm Hg at 77 °F (25 °C)

Formula Weight: 200.59

Density ($\text{H}_2\text{O}=1$): 13.534 g/cm³ at 77 °F (25 °C)

Boiling Point: 674.09 °F (356.72 °C)

Freezing Point: -37.97 °F (-38.87 °C)

Viscosity: 15.5 mP at 77 °F (25 °C)

Electrical Resistivity: 95.76 μohm at 68 °F (20 °C)

Water Solubility: 0.28 $\mu\text{mol/L}$ at 77 °F (25 °C)

Other Solubilities: Soluble in boiling sulfuric acid, nitric acid (reacts); slightly in lipids, and 2.7 mg/L in pentane. Insoluble in alcohol, ether, cold sulfuric acid, hydrogen bromide, and hydrogen iodide.

Surface Tension: 484 dyne/cm at 77 °F (25 °C)

Critical Temperature: 2664 °F (1462 °C)

Critical Pressure: 1587 atm

Section 10 - Stability and Reactivity

Stability: Mercury does not tarnish at ordinary temperatures but when heated to near its boiling point, it slowly oxidizes to mercuric oxide.

Polymerization: Hazardous polymerization does not occur.

Chemical Incompatibilities: Mercury forms alloys (amalgamates) with most metals except iron. It is incompatible with oxidizers such as bromine, 3-bromopropyne, methylsilane + oxygen, chlorine, chlorine dioxide, nitric acid, or peroxyformic acid; tetracarbonyl nickel + oxygen, alkynes + silver perchlorate, ethylene oxide, acetylenic compounds (explosive), ammonia (explosive), boron phosphodiiodide, methyl azide, nitromethane, and ground sodium carbide.

Conditions to Avoid: Exposure to high temperatures, metal surfaces or incompatibles.

Hazardous Decomposition Products: Thermal oxidative decomposition of mercury can produce mercuric oxide.

Section 11- Toxicological Information

Toxicity Data:*

Reproductive:

Rat, inhalation: 890 ng/m³/24 hr for 16 weeks prior to mating had an effect on spermatogenesis.

Acute Dermal Toxicity:

Man, skin, TD_{Lo} : 129 mg/kg for 5 continuous hours caused ringing in the ears, headache, and allergic dermatitis.

Acute Oral Toxicity:

Man, oral, TD_{Lo} : 43 mg/kg caused tremor and jaundice or other liver changes.

Acute Inhalation Effects:

Woman, inhalation, TC_{Lo} : 150 $\mu\text{g/m}^3$ /46 days caused anorexia, diarrhea, and wakefulness.

Man, inhalation, TC_{Lo} : 44300 $\mu\text{g/m}^3$ /8 hr caused muscle weakness, liver changes, and increased body temperature.

Chronic Effects:

Rat, inhalation: 1 mg/m³/ 24 hr for 5 continuous weeks caused proteinuria.

* See NIOSH, RTECS (OV4550000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: Catfish, $LC_{50} = 0.35$ mg/L/96 hr; mollusk (*Modiolus carvalhoi*), $LC_{50} = 0.19$ ppm/96 hr; tadpole (*Rana hexadactyla*), $LC_{50} = 0.051$ ppm/96 hr. Mercury is transformed to methyl mercury by bacteria in the environment and undergoes bioaccumulation readily. BCF for freshwater fish = 63,000; for saltwater fish = 10,000; and for marine and freshwater invertebrates = 100,000.

Environmental Degradation: Mercury is expected to volatilize rapidly when deposited on soil surfaces. Once in the air, it can be transported long distances before being redeposited on soil or in water. In water, mercury appears to bind to particulates where it eventually becomes deposited on the bed sediment. In general, mercury entering the environment can be deposited and revolatilized several times.

Section 13 - Disposal Considerations

Disposal: Incineration is *not* an appropriate disposal method. Wastewater may be treated by addition of chlorine to oxidize the mercury to its ionic state. The water can then be passed through an absorbent (an activated charcoal concentrate with a sulfur coating or peanut shell charcoal) to collect the ionic mercury, followed by distillation to recover the mercury. Sodium borohydride, a reducing agent, can be used to precipitate mercury from waste solutions. Bioremediation, using *Pseudomonas putida*, has also been suggested. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Mercury

Shipping Symbols: A, W

Hazard Class: 8

ID No.: UN2809

Packing Group: III

Label: Corrosive

Special Provisions (172.102): -

Packaging Authorizations

a) Exceptions: 173.164

b) Non-bulk Packaging: 173.164

c) Bulk Packaging: 173.240

Quantity Limitations

a) Passenger, Aircraft, or Railcar: 35 kg

b) Cargo Aircraft Only: 35 kg

Vessel Stowage Requirements

a) Vessel Stowage: B

b) Other: 40, 97

Section 15 - Regulatory Information

EPA Regulations:

Listed as a RCRA Hazardous Waste (40 CFR 261.33): U151

Listed as a CERCLA Hazardous Substance (40 CFR 302.4) per RCRA, Sec. 3001; CWA, Sec. 307(a), CAA, Sec. 112

CERCLA Reportable Quantity (RQ), 1 lb (0.454 kg)

SARA 311/312 Codes: 1, 2

Listed as a SARA Toxic Chemical (40 CFR 372.65)

SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed

OSHA Regulations:

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A)

Section 16 - Other Information

References: 73, 103, 124, 132, 136, 148, 149, 159, 167, 176, 187, 189

Prepared By M Gannon, BA

Industrial Hygiene Review RE Langford, PhD, CIH

Medical Review T Thoburn, MD, MPH

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One Genium Plaza
Schenectady, NY 12304-4690 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 334C
Mineral Spirits, Type IV

Issued: 4/90

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Section 1. Material Identification

Mineral Spirits, Type IV, Description: A low dry point mineral spirit. Used as a solvent and paint thinner, in the coatings and dry cleaning industries.

Other Designations: CAS No. 8052-41-3; Texsolve S-2; Varsol 3; stoddard solvent; white spirits.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*⁽⁷³⁾ for a suppliers list.

Comments: All mineral spirits are refined petroleum distillates that Genium divides into types I, II, III, and IV (*MSDS Collection*, No. 334, 334A, 334B, and 334C, respectively). Types I and II have a standard aromatic content and 100 °F/37.78 °C and 140 °F/60 °C minimum flash points, respectively. Type III has a high aliphatic content (low or reduced aromatic content), little odor, and a 100 °F/37.78 °C minimum flash point; and type IV has a low dry point and a 100 °F/37.78 °C minimum flash point. These different types have different applications. Consult your manufacturer or supplier to ascertain the exact information applicable to your purchased mineral spirits.

R 1
I 3
S 1
K 2

Genium



HMIS

H 1

F 2

R 0

PPG*

* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Mineral spirits, type IV, ca 100%*

OSHA PEL
TWA: 100 ppm, 525 mg/m³

ACGIH TLV, 1989-90
TLV-TWA: 100 ppm, 525 mg/m³

NIOSH REL, 1987
10-hr TWA: 350 mg/m³
15-min ceiling: 1800 mg/m³

Toxicity Data†
Cat, inhalation, LC₅₀: 10 g/m³/2.5 hr
Human, eye: 470 ppm/15 min

* All mineral spirits are mixtures that typically consist of both straight and branched hydrocarbons, paraffins, naphthenes (cycloparaffins), and aromatic hydrocarbons. However, their physical properties divide them into types I, II, III, and IV. Since these parameters vary among suppliers, the purchaser must determine the mineral spirits' composition based on the supplier's information. Note that the mineral spirits' exact composition can affect disposal, shipping, approved uses, insurance policies, and regulatory liabilities.

† See NIOSH, *RTECS* (WJ8925000), for additional irritative data.

Section 3. Physical Data

Boiling Point: 300 °F/149 °C to 365 °F/185 °C*
Specific Gravity (H₂O = 1 at 39 °F/4 °C): 0.754 to 0.800

Molecular Weight: Not applicable (mixture)
Water Solubility: Insoluble

Appearance and Odor: A clear, colorless liquid; a kerosene-like odor usually perceptible to humans at about 1-ppm concentration.

* This 300 °F/149 °C to 365 °F/185 °C distillation range describes a specific cut of petroleum distillates, as well as defines and distinguishes these mineral spirits from many petroleum distillates (petroleum naphtha, petroleum ether, rubber solvent, kerosene, mineral seal oil, and others).

Section 4. Fire and Explosion Data

Flash Point: 100 °F/38.78 °C Autoignition Temperature: >450 °F/232 °C LEL: None reported UEL: None reported

Extinguishing Media: Use water fog, dry chemical, carbon dioxide (CO₂), or foams to put out fires involving this material. Never direct solid streams of water into burning pools of this liquid since this can scatter and spread the flames.

Unusual Fire or Explosion Hazards: During fires, or if heated or misted, this liquid is an explosive, flammable hazard. Finely dispersed mists are a dangerous explosion hazard.

Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Type IV is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: As a hydrocarbon mixture, type IV can react dangerously with strong oxidizing agents like chlorine and oxygen, as well as with nitric, sulfuric, and phosphoric acids.

Conditions to Avoid: Prevent exposures to heat and ignition sources and incompatible chemicals. Perform processing operations that heat or mist type IV in a careful, controlled manner that minimizes exposure of vapors or mists to possible heat or ignition sources such as lighted tobacco products, open flames, or uninsulated heating elements.

Hazardous Products of Decomposition: Thermal oxidative decomposition of type IV mineral spirits can produce carbon dioxide (CO₂) and carbon monoxide (CO). Depending on your material's exact composition and its unreported contaminants (benzene, toluene, or other aromatics or aliphatics), degradation products could include unidentified aromatic compounds and organics. When heated to decomposition, this material may explode.

Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists mineral spirits as a carcinogen.

Summary of Risks: Millions of industrial workers in chemical process and allied industries have been exposed to mineral spirits with minimal serious health effects, aside from the drying, defatting (stripping away of your skin's protective fats and emollients), and irritant skin effects. However, overexposure can depress the central nervous system (CNS) with these symptoms: headache, dizziness, drowsiness, intoxication with euphoria, and possibly unconsciousness. Prolonged or repeated skin contact can cause dermatitis due to this mineral spirits' defatting effect or sensitization.

Medical Conditions Aggravated by Long-Term Exposure: None reported.

Target Organs: Skin, eyes, nose, throat, respiratory system, and CNS.

Primary Entry Routes: Skin or eye contact with the liquid or inhalation of vapors.

Acute Effects: Irritation, redness of skin and eyes; narcotic effects like dizziness, slurred speech, or drunkenness. Ingestion may cause nausea, vomiting, diarrhea, and abdominal pain. After ingestion, the primary concern is aspiration into the lungs. Signs of aspiration pneumonitis include: fever, shortness of breath, increased rate of respiration, and rales (an abnormal rattling sound in the throat). Inhaling this material may cause arrhythmias.

Chronic Effects: None reported in humans; animal testing indicates possible liver and kidney damage.

FIRST AID

Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.

Skin: Quickly remove contaminated clothing. After rinsing affected skin with flooding amounts of water, wash it with soap and water.

Inhalation: Inhalation may cause potentially lethal heart rhythm disturbances. Remove exposed person to fresh air and support breathing as needed.

Ingestion: Treat as an emergency. Potentially fatal aspiration hazard exists. To prevent aspiration, keep victim's head down between his knees. Never give anything by mouth to an unconscious or convulsing person. Never induce vomiting unless directed by qualified medical personnel.

Even if aspiration into the lungs does not occur, ingestion of 3 to 4 oz can prove fatal in humans due to the CNS's depressed action.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Physician's Note: Aspiration of even a few milliliters of mineral spirits can be fatal! The resulting diffused chemical irritation of the lungs can progress to fatal pulmonary edema after aspirating liquid mineral spirits. To prevent their aspiration of freshly vomited solvent, carefully monitor persons who swallow mineral spirits. Consider intubation in treating any significant ingestion.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Design and practice a mineral spirits spill control and countermeasure plan (SCCP). When a spill occurs, notify safety personnel, eliminate heat and ignition sources, provide optimum explosion-proof ventilation, and implement the SCCP. Cleanup crews must use nonsparking tools and equipment and protective clothing to prevent vapor inhalation or skin contact. Absorb the spilled material with vermiculite or a similar material and place in appropriate disposal containers. Follow applicable OSHA regulations (29 CFR 1910.120).

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

RCRA Hazardous Waste (40 CFR 261.33): Not listed

CERCLA Hazardous Substance (40 CFR 302.4): Not listed

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

SARA Toxic Chemical (40 CFR 372.65): Not listed

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Subpart Z)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.

Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact.

Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL, ACGIH TLV, and NIOSH REL (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source. (103)

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics. Never inhale its mists or vapors, especially when processing operations heat or mist this material.

Section 9. Special Precautions and Comments

Storage Requirements: Store this material in a cool, dry, well-ventilated, fireproof area away from heat and ignition sources and oxidizing agents. Protect these containers from physical damage. Store in properly labeled, closed metal drums or safety cans.

Engineering Controls: To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations in production and storage areas. Use only nonsparking tools and equipment.

Comments: Shipping regulations vary with your particular mineral spirits' physical properties (flash point, boiling point). The data below represent one of several ways to classify mineral spirits, per the actual entries in the table of regulations. Before shipping mineral spirits, ascertain how the pertinent shipping rules apply to your product.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Petroleum distillate

DOT Hazard Class: Combustible liquid or Flammable liquid

ID No.: UN1268

DOT Label: None or Flammable liquid

DOT Packaging Requirements: None or 173.119

DOT Packaging Exceptions: 173.118a or 173.118

IMO Shipping Name: Petroleum distillates, n.o.s.

IMO Hazard Class: 3.1, 3.2, or 3.3

IMO Label: Flammable liquid

IMDG Packaging Group: II

ID No.: UN1268

MSDS Collection References: 1, 6, 7, 38, 73, 84-94, 100, 103, 116, 117, 119, 120, 122, 123, 124, 126

Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD



Material Safety Data Sheet

Genium Publishing Corporation

One Genium Plaza
Schenectady, NY 12304-4690 USA
(518) 377-8854

No. 84
MOLYBDENUM METAL/
POWDER
(Revision A)
Issued: March 1981
Revised: April 1988

SECTION 1. MATERIAL IDENTIFICATION

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Material Name: MOLYBDENUM METAL/POWDER

Description (Origin/Uses): Used to make specialty steels and nonferrous alloys; used in spark plugs and also as a lubricant additive.

Other Designations: Mo; NIOSH RTECS No. QA4680000; CAS No. 7439-98-7

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

Comments: The hazards of working with Molybdenum are associated with cutting, grinding, welding, etc., that produce dust, fumes, powders, and gases.

HMIS	Not	Found
H 1		
F 1	R 1	
R 0	I 2	
PPG*	S 1	
*See sect. 8	K -	

SECTION 2. INGREDIENTS AND HAZARDS

Molybdenum Metal/Powder; CAS No. 7439-98-7

%

EXPOSURE LIMITS

OSHA PEL
8-Hr TWA:* 5 mg/m³
8-Hr TWA:** 15 mg/m³

ACGIH TLVs, 1987-88
TLV-TWA:* 5 mg/m³
TLV-TWA:** 10 mg/m³

Toxicity Data***
Rat, Intraperitoneal, LD₅₀: 114 mg/kg

*Exposure limit defined for soluble molybdenum compounds as Mo.

**Exposure limit defined for insoluble molybdenum compounds as Mo.

***See NIOSH, RTECS, for additional data with references to reproductive and mutagenic effects.

Note: All exposure levels are defined for dust or fume.

SECTION 3. PHYSICAL DATA

Boiling Point: 10040°F (5560°C)

Melting Point: 4730°F (2610°C)

Specific Gravity (H₂O = 1): 10.28 at 68°F (20°C)

Water Solubility (%): Insoluble

Molecular Weight: 96 Grams/Mole

Appearance and Odor: A silver white metal or dark gray/black powder; odor not found.

SECTION 4. FIRE AND EXPLOSION DATA

LOWER

UPPER

Flash Point and Method

Autoignition Temperature

Flammability Limits in Air

*

*

% by Volume

*

*

Extinguishing Media: *Use dry chemical, "alcohol" foam, carbon dioxide, or water spray to put out molybdenum fires. Contact your supplier for further recommendations.

Unusual Fire or Explosion Hazards: Molybdenum dust particles suspended in the air can explode. If a molybdenum dust cloud forms, immediately eliminate all possible sources of ignition such as sparks, open flame, etc., and spray the affected area with a water mist or fog. When powdered molybdenum is exposed to heat or sources of ignition, it is a weak fire and explosion hazard; the solid metallic form of molybdenum is less reactive. Working with this material can produce heat and sparks, which can ignite flammable materials and vapors in the workplace.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Molybdenum metal/powder is stable in closed containers at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization.

Chemical Incompatibilities: Hazardous reactions are reported for molybdenum and bromine trifluoride, chlorine trifluoride, fluorine, and lead dioxide.

Conditions to Avoid: Do not expose powdered molybdenum to sources of ignition; prevent dust clouds from forming.

Hazardous Products of Decomposition: During fires molybdenum can form oxides such as molybdenum trioxide (MoO₃), which is irritating to the eyes, nose, and throat.

SECTION 6. HEALTH HAZARD INFORMATION

Molybdenum metal/powder is not listed as a carcinogen by the NTP, IARC, or OSHA.

Summary of Risks: Limited data suggest that molybdenum compounds have a relatively low order of toxicity. The metal itself (Mo), the ore molybdenite, and the dioxide (MoO_2) are less toxic than the more active and soluble molybdenum compounds such as ammonium molybdate and the trioxide (MoO_3). Molybdenum itself is a necessary trace element in humans that is closely associated with copper; excessive intake of molybdenum may cause a copper deficiency.

Medical Conditions Aggravated by Long-Term Exposure: None reported. **Target Organs:** None reported.

Primary Entry: Skin contact, inhalation. **Acute Effects:** Mild, transient irritation of eyes, nose, and throat; elevated serum uric acid levels have been reported. **Chronic Effects:** None reported.

FIRST AID

Eyes: Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes.

Skin: Wash the affected area with soap and water.

Inhalation: Remove the exposed person to fresh air; restore and/or support his or her breathing as needed.

Ingestion: Never give anything by mouth to someone who is unconscious or convulsing. Give the exposed person 1 to 2 glasses of water, then induce vomiting.

GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, evacuate all nonessential personnel, and provide adequate ventilation. Cleanup personnel need protection against contact with and inhalation of dust (see sect. 8). Scoop up spilled molybdenum into suitable containers for disposal. Carefully sweep or vacuum up small spills or residues without creating dust.

Waste Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Consider recycling. Follow Federal, state, and local regulations.

OSHA Designations

Air Contaminant (29 CFR 1910.1000 Subpart Z, for soluble and insoluble compounds as Mo)

EPA Designations (40 CFR 302.4)

RCRA Hazardous Waste: Not Listed

CERCLA Hazardous Substance: Not Listed

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Follow the eye- and face-protection guidelines in 29 CFR 1910.133. **Respirator:** Consult the *NIOSH Pocket Guide to Chemical Hazards* for general recommendations on respirators. Follow the respirator guidelines in 29 CFR 1910.134. For emergency or nonroutine use (e.g., cleaning reactor vessels or storage tanks), wear an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres.

Other: Wear impervious gloves, boots, and aprons, etc., as required by the work environment to prevent prolonged or repeated skin contact. Barrier creams may be useful to limit the effects of skin contact. **Ventilation:** Install and operate general and local ventilation systems powerful enough to maintain airborne levels of molybdenum below the OSHA PEL standard cited in section 2.

Safety Stations: Make eyewash stations, washing facilities, and safety showers available in use and handling areas.

Contaminated Equipment: Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.

Particles can adhere to contact lenses and cause corneal damage. Do *not* wear contact lenses in any work area.

Comments: Practice good personal hygiene; always wash thoroughly after using this material. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale molybdenum dust.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store molybdenum metal/powder in a cool, dry, well-ventilated area in closed containers away from sources of ignition and incompatible chemicals (see sect. 5).

Special Handling/Storage: Practice good housekeeping techniques to minimize accumulation of dust; cleaning procedures should not create dusty conditions.

Transportation Data (49 CFR 172.101-2): Not Listed

References: 1, 2, 12, 73, 84-94, 100, 103. PJI

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Prepared by PJ Igoe, BS

Industrial Hygiene Review: DJ Wilson, CIH

Medical Review: MJ Hardies, MD



Genium Publishing Corporation

One Genium Plaza
Schenectady, NY 12304-4690 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 723

Nickel Metal

Issued: 8/90

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Section 1. Material Identification

Nickel (Ni) Description: Found in ores in combination with sulphur, oxygen, antimony, arsenic, and/or silica. The Orford (sodium sulfide and electrolysis) and the Mond (nickel carbonyl) processes are used to refine nickel. Used in electroplating, casting operations for machine parts, manufacturing acid-resisting and magnetic alloys and tapes, synthesizing acrylic esters; in surgical and dental prostheses, coinage, catalytic gastrification of coal, paint pigments, Ni-Cd batteries, ceramics and glass; and as a catalyst in hydrogenation of fats and oils.

Other Designations: CAS No. 7440-02-0, Raney alloy, Raney nickel.*

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*⁽⁷³⁾ for a suppliers list.

Cautions: Nickel is an eye, skin, and respiratory tract irritant. *Chronic inhalation of nickel dust or fumes may cause cancer of the lungs and nasal passages. Nickel powder (Raney nickel) is a dangerous fire hazard.*

R 0
I 3
S 2
K 1

NFPA



catalyst

HMIS

H 2

F 4

R 0

PPG†

Genium



metal

HMIS

H 2

F 1

R 0

PPG†

† Sec. 8

* Raney nickel is prepared by leaching (with 25% caustic soda solution) aluminum from an alloy of 50% aluminum and 50% nickel. It is used as a catalyst for hydrogenation. Raney nickel, a silvery gray metal powder, is a dangerous fire risk and ignites spontaneously in air (Sec. 4). Nickel catalysts cause many industrial accidents.

Section 2. Ingredients and Occupational Exposure Limits

Nickel, ca 100%

1989 OSHA PEL

8-hr TWA: 1 mg/m³

1989-90 ACGIH TLV

TLV-TWA: 1 mg/m³

1988 NIOSH REL

0.015 mg/m³

1985-86 Toxicity Data*

Dog, intravenous, LD₅₀: 10 mg/kg

Guinea pig, oral, LD₅₀: 5 mg/kg

Rat, implant, TD₅₀: 250 mg/kg

* See NIOSH, RTECS (QR5950000), for additional mutative, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 4946 °F (2730 °C)

Melting Point: 2651 °F (1455 °C)

Vapor Pressure: 1 mm at 3290 °F (1810 °C)

Atomic Weight: 58.71

Density: 8.90 at 25 °C

Water Solubility: Insoluble

Appearance and Odor: A silvery-white, hard, malleable and ductile metal.

Section 4. Fire and Explosion Data

Flash Point: None reported

Autoignition Temperature: None reported

LEL: None reported

UEL: None reported

Extinguishing Media: Smother with suitable dry powder or use large amounts of water.

Unusual Fire or Explosion Hazards: Nickel is combustible as dust or powder. Raney nickel ignites spontaneously in air. Nickel carbonyl (MSDS Collection, No. 226), a highly toxic substance, may form under fire conditions.

Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since nickel dust or powder is toxic if inhaled, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective equipment. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Nickel is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Nickel can react violently with fluorine, ammonium nitrate, hydrogen + dioxane, performic acid, selenium, sulfur, ammonia, hydrazine, phosphorus, and titanium + potassium chlorate. Nickel is also incompatible with oxidants. Raney nickel catalysts may initiate hazardous reactions with sulfur compounds, *p*-dioxane, hydrogen, hydrogen + oxygen, ethylene + aluminum chloride, magnesium silicate, methanol, and organic solvents + heat.

Conditions to Avoid: Avoid incompatibilities.

Hazardous Products of Decomposition: Thermal oxidative decomposition of nickel can produce highly toxic nickel carbonyl.

Section 6. Health Hazard Data

Carcinogenicity: The IARC and NTP classify nickel as, respectively, a human carcinogen (Group 1) and an anticipated human carcinogen. **Summary of Risks:** Nickel dust or fume is a respiratory irritant that with chronic exposure may cause nasal or lung cancer in humans. The average latency period for the induction of these cancers appears to be about 25 yr (within a 4- to 51-yr range). Experimental studies show nickel also has neoplastic, tumorigenic, and teratogenic effects in laboratory animals. Hypersensitivity to nickel is common and can cause conjunctivitis, allergic contact dermatitis, and asthma. The allergic contact dermatitis ("nickel-itch," a pink papular erythema with pustulation and ulceration) usually clears within one week, but sensitization is permanent.

Medical Conditions Aggravated by Long-Term Exposure: Chronic pulmonary, upper respiratory tract, and skin disorders. Carcinoma of the paranasal sinuses, larynx, and lung may also develop.

Target Organs: Nasal cavities, lungs, skin.

Primary Entry Routes: Inhalation, dermal contact, and ingestion.

Acute Effects: Exposure to nickel fumes can cause upper respiratory tract irritation (with nonproductive cough, rapid breathing, dyspnea, chest tightness), metal fume fever (chills, fever, flu-like symptoms), asthma, inflammation of the lungs (noninfectious pneumonia), eye (conjunctiva) irritation, nausea, vomiting, and abdominal pain. Dermal contact causes "nickel itch." Ingesting large doses causes nausea, vomiting, and diarrhea. **Chronic Effects:** Prolonged or repeated contact can cause nickel sensitization. Symptoms of sensitization include nickel dermatitis with eczematous skin and lichenification (hardened and leathery skin). Chronic inhalation exposure can cause chronic pulmonary irritation, chronic thickening of the mucous membranes of the nose, nasal sinusitis, anosmia (loss or impairment of the sense of smell), and perforation of the nasal septum.

Chronic exposure to dust and fumes may cause carcinoma of paranasal sinuses, larynx, and lung.

FIRST AID

Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin: Quickly remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Since oral toxicity for elemental nickel is low, inducing vomiting is seldom necessary. In cases of severe vomiting or diarrhea, treat for fluid replacement.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Physician's Note: Chronic exposure to nickel dust may cause *eosinophilic pneumonitis* (Loeffler's syndrome) which responds well to systemic cortico-steroids. There are cases of host rejection of nickel-containing prostheses after development of nickel sensitivity.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, remove all heat and ignition sources, and provide maximum explosion-proof ventilation. Cleanup personnel should protect against vapor inhalation and dermal contact. Avoid dust generation. Using nonsparking tools, carefully scoop spilled material into appropriate containers for reclamation or disposal. After completing material pickup, wash spill site. Do not release to sewers or waterways. Follow applicable OSHA regulations (29 CFR 1910.120).

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

RCRA Hazardous Waste (40 CFR 261.33): Not listed

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* per Clean Water Act, Sec. 307(a)]

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. **Warning!** Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.

Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL, ACGIH TLV, and NIOSH REL (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.⁽¹⁰³⁾

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, dry, well-ventilated area away from incompatible materials (Sec. 2). Protect against physical damage. Store Raney nickel under inert gas or water in tightly closed containers away from heat or ignition sources, acids, caustics, and oxidizing materials.

Engineering Controls: Minimize all possible exposures to potential carcinogens. Avoid vapor inhalation and dermal contact. Use only with appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good personal hygiene and housekeeping procedures.

Other Precautions: Provide preplacement and periodic medical examinations that emphasize the skin, nasal cavities, and lungs, including a 14" x 17" chest roentgenogram and urine nickel determinations.

Transportation Data (49 CFR 172.102)

IMO Shipping Name: Nickel catalyst, wetted with not less than 40% water or other suitable liquid, by weight, finely divided, activated, or spent

IMO Hazard Class: 4.2

ID No.: UN1378

IMO Label: Spontaneously combustible

IMDG Packaging Group: II

MSDS Collection References: 26, 38, 73, 84, 85, 88, 89, 90, 100, 101, 103, 109, 124, 126, 132, 133, 134, 136, 138, 139, 140, 142, 143

Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD; **Edited by:** JR Stuart, MS



Section 1 - Chemical Product and Company Identification

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Product/Chemical Name: DDT (Dichlorodiphenyltrichloroethane)**Chemical Formula:** (ClC₆H₄)₂CHCCl₃**CAS No.:** 50-29-3**Synonyms:** Agritan; 2,2-bis(*p*-chlorophenyl)-1,1,1-trichloroethane; chlorophenothan; Citox; dichlorodiphenyltrichloroethane; Dicophane; diphenyltrichloroethane; Genitox; Kopsol; NCI-C00464; Neocid; Pentech; trichlorobis (4-chlorophenyl) ethane; 1,1'-(2,2,2-trichloroethylidene)bis(4-chlorobenzene), Zerdane.**Derivation:** Prepared by condensing chloral or chloral hydrate with chlorobenzene in presence of sulfuric acid.**General Use:** One of the most widely used contact insecticides from 1945 until its ban in 1972. Although banned in the U.S. (except for such uses as emergency health situations and for controlling body lice), it is still widely used in the tropics for control of vector-carrying diseases such as malaria, yellow fever, dengue, filariasis, louse-borne typhus, and louse-borne relapsing fever.

Section 2 - Composition / Information on Ingredients

DDT: *p,p'*DDT 70% wt + *o,p'*DDT 30% wt (technical grade)

Trace Impurities: DDD, DDE

OSHA PELs8-hr TWA: 1 mg/m³ (skin)**ACGIH TLVs**TWA: 1 mg/m³**NIOSH REL**10-hr TWA: 0.5 mg/m³Ca*: (Limit of quantitation: 0.1 mg/m³)**IDLH Level**

Ca*

DFG (Germany) MAK (skin)TWA: 1 mg/m³ (total dust)

Category III: Substances with systemic effects

Onset of effect: > 2 hr.

Peak Exposure Limit: 10 mg/m³, 30 min. average value, 1/shift

* Ca = Carcinogen

Section 3 - Hazards Identification

☆☆☆☆ Emergency Overview ☆☆☆☆

DDT is a white to gray, crystalline solid. Although it has been banned in the U.S. because of its persistence in the environment and potential for bioaccumulation, DDT has not produced toxicity in workers who either manufactured or used it (even over many years). However, this lack of toxicity is based on inhalation and skin absorption. If DDT is ingested, especially in large amounts, central nervous system effects will occur with possible liver damage. DDT is considered a confirmed animal carcinogen and a suspected human carcinogen.

Wilson Risk ScaleR 1
I 3
S 1*
K 2

*Skin absorption

HMSH 2†
F 2
R 0

†Chronic effects

PPE†

†Sec. 8

Potential Health Effects**Primary Entry Routes:** Inhalation, ingestion, skin contact.**Target Organs:** Central nervous system, liver, skin, peripheral nervous system.**Acute Effects****Inhalation:** Inhalation does not appear to cause toxicity beyond that of minor mechanical irritation.**Eye:** Exposure to 423 mg/m³/1 hr/day for 6 days caused eye irritation.**Skin:** Skin absorption may occur from some DDT solutions, but degree of absorption will depend on the solvent involved. Aqueous solutions and the powder or crystals are not easily absorbed.**Ingestion:** DDT can cause a variety of central nervous system effects if ingested. Large doses generally result in vomiting, while smaller doses cause symptoms within 2 to 3 hr post-ingestion. Symptoms include tingling of the lips, tongue, and face; malaise; headache; sore throat; fatigue; tremors of the head, neck, and eyelids; apprehension; ataxia; and confusion. Convulsions and paralysis of the hands is possible in severe exposures (if vomiting does not occur). Vital signs are usually normal, but in severe poisonings, the pulse may be irregular and abnormally slow. Based on animal studies, it is expected that ventricular fibrillation and sudden death can occur at any time during acute poisoning. Recovery from acute poisoning generally occurs within 24 hr except in the most serious cases.**Carcinogenicity:** DDT is considered a suspected human carcinogen by several governmental agencies. IARC-2B (possibly carcinogenic to humans, limited evidence in humans in the absence of sufficient evidence in experimental animals), NTP-2 (reasonably anticipated to be a carcinogen: limited human evidence or sufficient animal evidence), EPA-B2 (sufficient animal evidence; inadequate human evidence), and NIOSH-X (carcinogen defined without further categorization)**Medical Conditions Aggravated by Long-Term Exposure:** Possibly, disorders of the central nervous system and liver.

Chronic Effects: There are conflicting reports on whether or not DDT produces chronic effects in humans. Although it is well established that chronic exposure in experimental animals produces effects including liver damage, CNS degeneration, dermatitis, weakness, convulsions, coma, and death, these effects are not confirmed in humans. Liver cancer is confirmed in animals, but has not been documented in humans. These conflicting reports appear due to the lack of documented chronic toxicity in workers and data showing that DDT and its metabolites are retained in the body fat for long time periods, thus providing a basis for the *possibility* of chronic toxicity.

Other: Solvents such as kerosine are added to DDT as a vehicle and, depending on the type involved, may be more toxic than DDT itself.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Eye Contact: Do not allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin Contact: Quickly remove contaminated clothing. Rinse away any loose material and wash exposed area with soap and water. For reddened or blistered skin, consult a physician. Carefully dispose of contaminated clothing because it may pose a fire hazard.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water to dilute. Do not induce vomiting. Gastric lavage should be performed promptly.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Notes to Physicians: Effects may be delayed; keep under observation.

Special Precautions/Procedures: Amobarbital or pentobarbital is recommended for the relief of central neurological manifestations; tribromoethanol and paraldehyde are recommended for allaying prolonged convulsions.

Section 5 - Fire-Fighting Measures

Flash Point: DDT itself is noncombustible but is dissolved in a variety of solvents. The average quoted Flash Point is 162 °F (72.2 °C) although the specific vehicle is not identified.

Flash Point Method: CC

Autoignition Temperature: None reported

LEL: None reported

UEL: None reported

Flammability Classification: Class IIIA Combustible Liquid (varies depending on vehicle)

Extinguishing Media: For small fires, use dry chemical, water spray, or regular foam. For large fires, use water spray, fog, or regular foam.

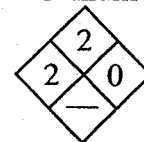
Unusual Fire or Explosion Hazards: Container may explode in heat of fire.

Hazardous Combustion Products: Chloride fumes and carbon oxide gases.

Fire-Fighting Instructions: Do not release runoff from fire control methods to sewers or waterways. Fight fire from maximum distance. Stay away from ends of tanks.

Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural fire fighters' protective clothing is *not* effective.

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Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel, isolate area, deny entry, and stay upwind. Shut off all ignition sources. Cleanup personnel should protect against contamination.

Small Spills: For dry spills, carefully scoop up material or vacuum (with an approved filter). Damp mop any residue. For small solution spills, take up with earth, sand, vermiculite, or other absorbent material and place in suitable containers for disposal.

Large Spills

Containment: Dike far ahead of liquid spill for later reclamation or disposal. Do not release into sewers or waterways.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Use non-sparking tools to open containers. Keep dry chemical extinguishers on hand in case of fire.

Storage Requirements: Prevent physical damage to containers. Store in a cool, dry, well-ventilated area away from heat, ignition sources, and incompatibles (Sec. 10). Do not store in aluminum or iron containers.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: To prevent static sparks, electrically ground and bond all equipment used with and around DDT.

Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source. (103)

Administrative Controls: Consider preplacement and periodic medical exams of exposed workers with emphasis on the liver and central nervous system.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For any detectable concentration, use a SCBA with a full facepiece and operated in pressure demand or other positive-pressure mode, or any supplied-air respirator with a full facepiece and operated in pressure demand or other positive-pressure mode with an auxiliary SCBA. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets made of butyl rubber to prevent prolonged or repeated skin contact. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy.

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove this material from your shoes and clean personal protective equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Solid

Appearance and Odor: White to gray crystals or powder which is odorless or has a slight aromatic odor.

Odor Threshold: 5.0725 mg/m³

Vapor Pressure: 5.5×10^{-6} mm Hg at 68 °F (20 °C)

Formula Weight: 354.48

Specific Gravity (H₂O=1, at 4 °C): 0.98 to 0.99

Water Solubility: 0.0012 ppm

Other Solubilities (g DDT/100 mL): acetone 58, 95% alcohol 2, benzene 78, benzyl benzoate 42, carbon tetrachloride 45, chlorobenzene 74, cyclohexanone 116, dibutyl phthalate 33, o-dichlorobenzene 68, dichlorodifluoromethane 2, dioxane 100, ethyl ether 28, gasoline 10, isopropanol 3, kerosine 8 to 10, methylated naphthalenes 40 to 60, mineral oil 5, morpholine 75, peanut oil 11, pine oil 0 to 16, tetralin 61, tributyl phosphate 50, and xylene 60.

Boiling Point: 365 °F (185 °C)

Melting Point: 227 °F (108.3 °C)

Section 10 - Stability and Reactivity

Stability: DDT is stable at room temperature in closed containers under normal storage and handling conditions. It biodegrades very slowly.

Polymerization: Hazardous polymerization does not occur.

Chemical Incompatibilities: Strong oxidizers, alkaline materials, iron and aluminum salts.

Conditions to Avoid: Exposure to heat, ignition sources, and incompatibles.

Hazardous Decomposition Products: Thermal oxidative decomposition of DDT can produce carbon dioxide.

Section 11- Toxicological Information

Toxicity Data: *

Eye Effects: None reported.

Skin Effects: None reported.

Acute Oral Effects:

Human, oral, LD₅₀: 500 mg/kg caused convulsions, cardiac arrhythmias, and respiratory changes.

Rat, oral, LD₅₀: 87 mg/kg; details not reported

Carcinogenicity: Rat, oral, TD_{Lo}: 1225 mg/kg given for 7 continuous weeks caused liver tumors.

Mutagenicity: *E. coli*: 15 µmol/L caused DNA damage.

Teratogenicity: Rat, oral, TD_{Lo}: 112 mg/kg given to a 56 day old male caused paternal effects (spermatogenesis, testes, epididymis, sperm duct).

* See NIOSH, RTECS (KJ3325000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: Glass shrimp (*Palaemonestes kadiakensis*), LC₅₀ = 2.3 mcg/L/96 hr at 69.8 °F (21 °C); Japanese quail, 2 month old male, (*Coturnix japonica*), LD₅₀ = 841 mg/kg; bluegill (*Lepomis macrochirus*), LC₅₀ = 28.7 mcg/L/36 hr.

Environmental Degradation: In water, DDT will adsorb strongly to sediments, significantly bioconcentrate in fish, and will be subject to considerable evaporation with an estimated half-life of several hr to almost 50 hr from certain waters. It may biodegrade when high concentrations of required microbes (*Escherichia*, *Hydrogenomonas*, and *Saccharomyces*) are present. On land, DDT will adsorb strongly and should not appreciably leach to groundwater. It may evaporate (half-life of 100 days) and is subject to photooxidation from soil. DDT may significantly biodegrade in flooded soils or under anaerobic conditions provided high populations of the required microbes are present. Half-life ranges from 2 to >15 yr. In the air, DDT is subject to direct photooxidation and reaction with photochemically produced hydroxyl radicals (est. half-life = 2 days). Wet and dry deposition are significant mechanisms for removal from air.

Section 13 - Disposal Considerations

Disposal: DDT is a good candidate for rotary kiln or liquid injection incineration (furnace with afterburner and alkali scrubber). 60 to 80% removal of DDT from contaminated soils has been achieved in 10 min. by super critical-carbon dioxide extraction. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Container Cleaning and Disposal: Triple rinse containers. Containers in good condition should be returned to the manufacturer and those that are not reusable should be punctured and transported to a scrap metal facility for recycling, disposal, or burial in a designated landfill.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Organochlorine pesticides, solid toxic, n.o.s.

Shipping Symbols: —

Hazard Class: 6.1

ID No.: UN2761

Packing Group: III

Label: Keep Away From Food

Special Provisions (172.102): —

Packaging Authorizations

a) Exceptions: 173.153

b) Non-bulk Packaging: 173.213

c) Bulk Packaging: 173.240

Quantity Limitations

a) Passenger, Aircraft, or Railcar: 100 kg

b) Cargo Aircraft Only: 200 kg

Vessel Stowage Requirements

a) Vessel Stowage: A

b) Other: 40

Section 15 - Regulatory Information

EPA Regulations:

RCRA Hazardous Waste Number (40 CFR 261.33): U061

Listed as a RCRA Hazardous Waste Classification (40 CFR 261.33)

Listed as a CERCLA Hazardous Substance (40 CFR 302.4) per RCRA, Sec. 3001; CWA, Sec. 311 (b)(4); and CWA, Sec. 307(a)

CERCLA Reportable Quantity (RQ), 1 lb (0.454 kg)

SARA Toxic Chemical (40 CFR 372.65): Not listed

SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed

OSHA Regulations:

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A)

Section 16 - Other Information

References: 73, 101, 103, 124, 126, 127, 132, 133, 136, 139, 148, 153, 167, 168, 169, 176, 180, 183

Prepared By M Gannon, BA

Industrial Hygiene Review PA Roy, MPH, CIH

Medical Review T Thoburn, MD, MPH

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Genium Publishing Corp.

One Genium Plaza
Schenectady, NY 12304-4690
(518) 377-8854

Material Safety Data Sheet Collection

Malathion

MSDS No. 177

Date of Preparation: 6/94

Section 1 - Chemical Product and Company Identification

44

Product/Chemical Name: Malathion

Chemical Formula: $(\text{CH}_3\text{O})_2\text{P}(\text{S})\text{SCH}(\text{COOC}_2\text{H}_5)\text{CH}_2\text{COOC}_2\text{H}_5$

CAS No.: 121-75-5

Synonyms: carbophos; Cythion; O,O-dimethyl dithiophosphate of diethyl mercaptosuccinate; O,O-dimethyl-S-(1,2-dicarbethoxyethyl) phosphorodithioate; Maldison; mercaptothion

Derivation: Obtained from diethyl maleate and dimethyldithiophosphoric acid. **General Use:** As an insecticide for the control of mosquitoes, flies, spiders, animal ectoparasites, and human head and body lice. **Vendors:** Consult the latest *Chemical Week Buyers' Guide*. (73)

Section 2 - Composition / Information on Ingredients

Malathion, 99.6 % vol: technical grade; 25% and 50%: wettable powders

Trace Impurities: phosphorothioate and phosphorodithioate; malaoxon (crude grade impurity)

OSHA PELs, Skin

8-hr TWA: 15 mg/m³, total dust

NIOSH REL, Skin

10-hr TWA: 10 mg/m³

DFG (Germany) MAK

Ceiling: 15 mg/m³, total dust

Vacated 1989 Final Rule Limit:

8-hr TWA: 10 mg/m³, total dust

5 mg/m³, respirable fraction

IDLH Level

5000 mg/m³

ACGIH TLVs, Skin

TWA: 10 mg/m³*

* Biological Exposure Index for organophosphorus cholinesterase inhibitors: 70% of individual's baseline.

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Malathion is a colorless (when pure) to light-amber liquid with a skunk-like or garlic odor. It is an anticholinesterase agent and severe intoxication causes profound pulmonary secretions and respiratory distress. Take the necessary precautions to prevent any exposure to malathion. It is absorbed through the skin and may produce systemic effects.

Potential Health Effects

Primary Entry Routes: Inhalation, ingestion, skin absorption.

Target Organs: Respiratory system, liver, blood cholinesterase, gastrointestinal tract, and central nervous and cardiovascular systems.

Acute Effects

Severe Intoxication by all Routes: Weakness, general twitching and paralysis, dizziness, confusion, staggering, slurred speech, sweating, irregular or slow heartbeat, convulsions, breathing may stop, and coma. **Inhalation:** Tightness of the chest, wheezing, increased pulmonary secretions, bluish discoloration of skin, small pupils, aching in and behind eyes, blurred vision, tearing, runny nose, headache, and watering of the mouth. **Eye:** Irritation.

Skin: Skin absorption causes sweating and twitching in area of absorption usually within 15 min to 4 hr. Weak skin sensitization and dermatitis may occur at high exposures.

Ingestion: Loss of appetite, nausea, vomiting, abdominal cramps, diarrhea within 2 hr.

Carcinogenicity: IARC, NTP, and OSHA do not list malathion as a carcinogen. IARC designates malathion as Group 3 (not classifiable as to carcinogenicity to humans).

Medical Conditions Aggravated by Long-Term Exposure: Central nervous system disorders.

Chronic Effects: Repeated exposure to malathion may make a person more susceptible to the effects of organophosphates.

Comments: Malathion is an anticholinesterase agent which causes the inactivation of the enzyme cholinesterase resulting in the accumulation of acetylcholine at synapses in the neuromuscular system and secretory glands. It is less toxic to humans than most anticholinesterase agents because malathion and its metabolite, malaoxon, are metabolized in the liver to an inactive form. The acute lethal dose is estimated to be somewhat below 1.0 g/kg.

**Wilson
Risk
Scale**

R 1
I 2
S 1*
K 1

* Skin
absorption

HMIS

H 2
F 1
R 1

PPE†

†Sec. 8

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Eye Contact: Do not allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician or ophthalmologist immediately.

Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Thoroughly wash exposed area with soap and water. Do repeat soap washings. For reddened or blistered skin, consult a physician.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, *do not* induce vomiting because of possible early onset of respiratory depression and seizures. Consider gastric lavage after control of any seizures.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Give 5 mg of atropine intravenously. Atropine may induce ventricular fibrillation in the presence of cyanosis. Repeat the dose of atropine at 5- to 10-minute intervals until signs of atropinization appear (dry, flushed skin, tachycardia as high as 140 beats/min, and pupillary dilatation). Repeat the dose of atropine if muscarinic symptoms appear. Maintain a mild degree of atropinization for at least 48 hr. Pralidoxime (2-PAM, Protopam) chloride is a cholinesterase reactivator that complements the action of atropine. For moderate-to-severe cases, give adults 1 to 2 g intravenously at a rate not in excess of 500 mg/min. A second dose of 1 g is indicated if muscle weakness has not been relieved, or if it recurs within 20 min. Pralidoxime chloride is ineffective after aging has occurred. Morphine, aminophylline, and phenothiazines are contraindicated. Depression in red blood cell cholinesterase in excess of 50% activity is generally associated with severe symptoms. Correlation between cholinesterase levels and clinical effects in milder poisonings may be poor. Individuals homozygous for the CHE gene display a defective serum butyrylcholinesterase and are particularly vulnerable to poisoning by organophosphorus insecticides.

Special Precautions/Procedures: Emergency personnel should protect against exposure when rescuing victims.

Section 5 - Fire-Fighting Measures

Flash Point: >325 °F (>163 °C)

Flash Point Method: OC

Autoignition Temperature: None reported.

LEL: None reported.

UEL: None reported.

Flammability Classification: Class IIIB Combustible Liquid, but may be difficult to ignite.

Extinguishing Media: Small fires: use dry chemical or carbon dioxide. Large fires: use water spray or foam.

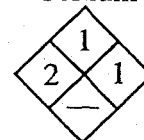
Unusual Fire or Explosion Hazards: Containers may explode in the heat of fire.

Hazardous Combustion Products: Sulfur dioxide, phosphoric acid, phosphorus oxides, and carbon monoxide.

Fire-Fighting Instructions: If feasible and without undue risk, move containers from fire hazard area. Otherwise, cool fire-exposed containers with water spray until well after fire is extinguished. Do not release runoff from fire control methods to sewers or waterways.

Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing is *not* effective. Wear chemically protective clothing specifically recommended by the manufacturer. Decontaminate equipment and clothing with a chlorine bleach solution.

Genium



Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel of large spills, evacuate all unnecessary personnel, provide adequate ventilation, and remove all heat and ignition sources. Cleanup personnel should protect against exposure. Fully-encapsulating, vapor-protective clothing (polycarbonate, butyl rubber, PVC, nitrile, Neoprene) is recommended.

Small Spills: Take up with sand or noncombustible absorbent material and place into containers for later disposal. For dry spills, scoop up with a clean shovel and place into a clean, dry container for disposal.

Large Spills

Containment: For large spills, dike far ahead of liquid spill for later disposal. Do not release into sewers or waterways.

Cleanup: Decontaminate equipment and surfaces with an alkaline solution (5% sodium hydroxide).

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid any contact with skin or vapor inhalation. Use only with adequate personal protective equipment and proper ventilation.

Storage Requirements: Store in tightly closed and properly labeled containers in a cool, well-ventilated area. Outdoor or detached storage is preferred. *Do not* store in iron, steel, tin plate, lead, or copper containers.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations in production and storage areas.

Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source. (103)

Administrative Controls: Provide preplacement and periodic medical exam with emphasis on the respiratory system, liver, and blood cholinesterase levels. Biological Exposure Index (BEI): cholinesterase activity in red blood cells (timing is discretionary) is 70% of individual's baseline. Background levels are included in the BEI value. Consider precluding from exposure those

individuals whose red blood cell cholinesterase falls to or below 40% of the preexposure baseline until the activity returns to within 70% of the preexposure baseline. **Respiratory Protection:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For concentrations $\leq 100 \text{ mg/m}^3$, wear any supplied-air respirator, any SCBA, or any chemical cartridge respirator with organic vapor cartridge(s) in combination with a dust, mist, and fume filter. For concentrations $\leq 250 \text{ mg/m}^3$, wear any supplied-air respirator operated in a continuous-flow mode; or any powered, air-purifying respirator with organic vapor cartridge(s) in combination with a dust, mist, and fume filter. For concentrations $\leq 500 \text{ mg/m}^3$, wear any self-contained breathing apparatus with a full facepiece or any supplied-air respirator with a full facepiece or any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter; or any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having a high-efficiency particulate filter; or any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter; or any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode. For concentrations $\leq 5000 \text{ mg/m}^3$, wear any supplied-air respirator operated in a pressure-demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. **Warning!** Air-purifying respirators do not protect workers in oxygen-deficient atmospheres. If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Protective Clothing/Equipment:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Whole-body coveralls and chemically protective footwear are recommended. Wear protective eyeglasses or chemical safety, splash-proof goggles and face shields (8 inch minimum) per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area. **Contaminated Equipment:** Separate contaminated work clothes from street clothes. Launder before reuse. Remove this material from your shoes and clean personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Liquid

Appearance and Odor: Colorless (when pure) to light amber with a skunk-like or garlic odor

Odor Threshold: 13.5 mg/m^3

Vapor Pressure: $1.25 \times 10^{-4} \text{ mm Hg}$ at 68°F (20°C); 4×10^{-5} at 86°F (30°C)

Formula Weight: 330.36

Density ($\text{H}_2\text{O}=1$, at 4°C): 1.23 at 77°F (25°C)

Water Solubility: Slightly soluble; 145 ppm at 20°C

Other Solubilities: Alcohols, esters, ketones, ethers, vegetable oils, benzene, hexane, aromatic and alkylated aromatic hydrocarbons; limited solubility in paraffin hydrocarbons

Boiling Point: 140°F (60°C); decomposes

Freezing/Melting Point: 37.2°F (2.9°C)

Refraction Index: 1.4960 at 20°C/D

Surface Tension: 37.1 dynes/cm at 75°F (24°C)

Octanol/Water Partition Coefficient: Log Kow=2.36

Section 10 - Stability and Reactivity

Stability: Malathion is stable in an aqueous solution buffered to pH 5.26. **Polymerization:** Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Corrodes iron, steel, tin plate, lead and copper; will attack some forms of plastics, rubber, and coatings; and is also incompatible with strong oxidizers, magnesium, and alkaline pesticides. **Conditions to Avoid:** Avoid heat and ignition sources and incompatibles. **Hazardous Decomposition Products:** Thermal oxidative decomposition of malathion can produce sulfur dioxide, phosphoric acid, carbon monoxide, and phosphorus oxides. Malathion may isomerise at high temperatures and form the more toxic isomalathion. It starts to decompose at 140°F (60°C) and at $> 212^\circ \text{F}$ ($> 100^\circ \text{C}$) it decomposes explosively.

Section 11- Toxicological Information

Toxicity Data:*

Acute Inhalation Effects:

Rat, inhalation, LC_{50} : $84600 \text{ } \mu\text{g/m}^3/4 \text{ hr}$

Acute Effects:

Woman, oral, LD_{50} : 246 mg/kg caused blood pressure lowering not characteristic in autonomic section, chronic pulmonary edema, and dermatitis.

Man, oral, LD_{50} : 471 mg/kg caused coma, blood pressure lowering not characteristic in autonomic section, and shortness of breath.

Rat, oral, LD_{50} : 290 mg/kg

Rat, skin, LD_{50} : $> 4444 \text{ mg/kg}$

Reproductive Effects:

Rat, oral, 283 mg/kg administered to the female during 9 days of pregnancy caused specific developmental abnormalities of the urogenital system.

Genetic Effects:

Human, lymphocyte: 70 mg/L caused DNA inhibition.
Human, fibroblast: 5 mg/L caused sister chromatid exchange.

* See NIOSH, RTECS (WM8400000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: Bluegill, fresh water, TLm, 96 hr: 0.09 ppm; Marine crustaceae, 96 hr: 0.033-0.083 ppm. Waterfowl, LD₅₀: 1485 mg/kg. **Environmental Fate:** A Koc of 280 has been estimated on the reported solubility of 145 ppm at 20 °C, vapor pressure of 4×10^{-5} mm Hg at 30 °C, and a Henry's law constant of 1.2×10^{-7} atm m³/mol. **Environmental Degradation:** If released to water, malathion is subject to biodegradation and photodegradation at the surface and it may moderately absorb to sediment, but will not be expected to bioconcentrate in aquatic organisms. Volatilization from water should not be an important fate process. Hydrolysis in water may be an important fate process based on reported half-life range of 0.2 weeks at pH 8.0 to 21 weeks at pH 6.0. Products of hydrolysis include malaoxon; malathion, alpha and beta monoacid; O,O-dimethyl phosphorodithionic acid; diethyl fumarate; diethyl thiomalate; and O,O-dimethyl phosphorothionic acid. Iron catalyzes hydrolysis and humic substances accelerate photolysis. Persistence of malathion in water from 4 rivers ranged from 52% still present after 11 days to 21% after 14 days. Biodegradation may be an important fate process, especially in soils at pH <7 where the rate of hydrolysis may be slow relative to the rate of biodegradation. The major metabolite in soil is malathion beta monoacid. **Soil Absorption/Mobility:** Malathion will moderately bind to the soil and it will be subject to significant biodegradation and hydrolysis. Leaching is a viable route of transport in soil. Absorption is the best in high organic content, enhanced by the presence of metallic clays. The half-life in soil: 4 to average 6 days. **Analytical Method:** EPA Method 8141 is a gas chromatographic method used to determine malathion in ground water, soil, and non-water miscible waste.

Section 13 - Disposal Considerations

Disposal: Incinerate with flammable solvent in a furnace equipped with an afterburner and scrubber (permit-approved facility). Wastewater treatment technology: biological treatment and reverse osmosis. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations. **Container Cleaning and Disposal:** Triple rinse containers and dispose of waste water as you would dispose of malathion unless it can be used for diluent.

Section 14 - Transport Information**DOT Transportation Data (49 CFR 172.101):**

Shipping Name: Organophosphorus pesticides, liquid, toxic, n.o.s.

Shipping Symbols:

Hazard Class: 6.1

ID No.: UN3018

Packing Group: I

Label: POISON

Special Provisions (172.102): N76, T42

Packaging Authorizations

a) Exceptions: None

b) Non-bulk Packaging: 173.201

c) Bulk Packaging: 173.243

Quantity Limitations

a) Passenger, Aircraft, or Railcar: 1 L

b) Cargo Aircraft Only: 30 L

Vessel Stowage Requirements

a) Vessel Stowage: B

b) Other: 40

Section 15 - Regulatory Information**EPA Regulations:**

RCRA Hazardous Waste (40 CFR 261.33): Not listed*

Listed as a CERCLA Hazardous Substance (40 CFR 302.4) per CWA, Sec. 311 (b)(4)

CERCLA Reportable Quantity (RQ), 100 lb (45.4 kg)

SARA Toxic Chemical (40 CFR 372.65): Not listed

SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed

OSHA Regulations:

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A)

* Malathion may be classified as a RCRA Hazardous Waste, Characteristic of Corrosivity, because it corrodes steel. See 40 CFR 261.22 for specific criteria.

Section 16 - Other Information

References: 26, 73, 100, 101, 103, 124, 132, 136, 139, 140, 148, 153, 164, 167, 168, 174, 175, 176, 180, 183, 189, 190

Prepared By MJ Wurth, BS **Industrial Hygiene Review** RE Langford, PhD, CIH **Medical Review** J Brent, MD, PhD

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**Section 1. Material Identification**

Polychlorinated Biphenyls [$C_{12}H_{10-n}Cl_n$ ($n=3, 4, 5$)] **Description:** A class of nonpolar chlorinated hydrocarbons with a biphenyl nucleus (two benzene nuclei connected by a single C-C bond) in which any or all of the hydrogen atoms have been replaced by chlorine. Commercial PCBs are mixtures of chlorinated biphenyl isomers with varying degrees of chlorination. Prepared industrially by the chlorination of biphenyl with anhydrous chlorine in the presence of a catalyst such as ferric chloride or iron filings. Except for limited research and development applications, PCBs have not been produced in the US since 1977. When large quantities of PCBs were manufactured in the US, they were marketed under the tradename Aroclor (Monsanto) and were characterized by four digit numbers. The first two digits indicating biphenyls (12), triphenyls (54), or both (25, 44); the last two digits indicating the weight percent of chlorine. PCBs' thermal stability, nonflammability, and high dielectric capability made them very useful in electrical equipment. Formerly used as additives in hydraulic fluids, heat transfer systems, lubricants, cutting oils, printer's ink, fire retardants, asphalt, brake linings, automobile body sealants, plasticizers, adhesives, synthetic rubber, floor tile, wax extenders, dedusting agents, pesticide extenders, and carbonless reproducing paper. PCBs are still used in certain existing electrical capacitors and transformers that require enhanced electrical protection to avoid heating from sustained electric faults.

Other Designations: CAS No. 1336-36-3, Aroclor, Clophen, Chlorextol, chlorinated biphenyls, chlorinated diphenyl, chlorinated diphenylene, chloro biphenyl, chloro-1,1-biphenyl, Dykanol, Fenclor, Inerteen, Kaneclor, Montar, Noflamol, Phenoclor, Pyralene, Pyranol, Santotherm, Sovol, Therminol FR-1

Cautions: PCBs are potent liver toxins that may be absorbed through skin. Potentially, chronic or delayed toxicity is significant because PCBs accumulate in fatty tissue and may reasonably be anticipated to be carcinogens. PCBs are a bioaccumulative environmental hazard. When burned, decomposition products may be more hazardous than the PCBs.

R 1
I 4
S 3*
K 1
* Skin absorption

NFPA

HMIS
H 2†
F 1
R 0
PPE†
† Sec. 8
† Chronic Effects

Section 2. Ingredients and Occupational Exposure Limits

PCBs, contain various levels of polychlorinated dibenzofurans and chlorinated naphthalenes as contaminants

1991 OSHA PELs, Skin

8-hr TWA (Chlorodiphenyl, 42% chlorine): 1 mg/m³

8-hr TWA (Chlorodiphenyl, 54% chlorine): 0.5 mg/m³

1990 DFG (Germany) MAK, Danger of Cutaneous Absorption

TWA (Chlorodiphenyl, 42% chlorine): 0.1 ppm (1 mg/m³)

Category III: Substances with systemic effects, onset of effect > 2 hr., half-life > shift length (strongly cumulative)

Short-term Level: 1 ppm, 30 min., average value, 1 per shift

TWA (Chlorodiphenyl, 54% chlorine): 0.05 ppm (0.5 mg/m³)

Category III: (see above)

Short-term Level: 0.5 ppm, 30 min., average value, 1 per shift

1985-86 Toxicity Data*

Rat, oral, TD: 1250 mg/kg administered intermittently for 25 weeks produced liver tumors.

Mammal, oral, TD₀₁: 325 mg/kg administered to female for 30 days prior to mating and from the 1st to the 36th day of gestation produced effects on newborn (stillbirth; live birth index; viability index).

1990 NIOSH REL

TWA (Chlorodiphenyl, 42% chlorine): 0.001 mg/m³

TWA (Chlorodiphenyl, 54% chlorine): 0.001 mg/m³

1992-93 ACGIH TLVs, Skin *

TWA (Chlorodiphenyl, 42% chlorine): 1 mg/m³

TWA (Chlorodiphenyl, 54% chlorine): 0.5 mg/m³

* These guidelines offer reasonably good protection against systemic intoxication, but may not guarantee that chloroacne won't occur.

† See NIOSH, RTECS (TQ1350000), for additional reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data*

Boiling Point: 644-707 °F (340-375 °C)

Melting Point: 42%: -2.2 °F (-19 °C); 54%: 14 °F (-10 °C)

Vapor Pressure: 1 mm Hg at 100 °F (38 °C); 10⁻⁶ to 10⁻³ mm at 20 °C

Molecular Weight: 188.7 to 398.5

Specific Gravity: 1.3 to 1.8 at 20 °C

Water Solubility: Low solubility (0.007 to 5.9 mg/L)

Other Solubilities: Most common organic solvents, oils, and fats; slightly soluble in glycerol and glycols.

Appearance and Odor: PCBs vary from mobile oily liquids to white crystalline solids and hard non-crystalline resins, depending upon chlorine content.

* Physical and chemical properties vary widely according to degree and to the position of chlorination.

Section 4. Fire and Explosion Data

Flash Point: 286-385 °F (141-196 °C) OC*

Autoignition Temperature: 464 °F (240 °C)

LEL: None reported

UEL: None reported

Extinguishing Media: Use extinguishing media suitable to the surrounding fire. Use dry chemical, foam, carbon dioxide (CO₂), or water spray. Water spray may be ineffective. Use water spray to cool fire-exposed containers or transformers. Do not scatter PCBs with high-pressure water streams. **Unusual Fire or Explosion Hazards:** Combustion products (hydrogen chloride, phosgene, polychlorinated dibenzofurans, and furans) are more hazardous than the PCBs themselves. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Approach fire from upwind to avoid highly toxic decomposition products. Structural firefighter's protective clothing will provide limited protection. Do not release runoff from fire control methods to sewers or waterways. Dike for later disposal.

* Flash points shown are a range for various PCBs. Some forms do not have flash points.

Section 5. Reactivity Data

Stability/Polymerization: PCBs are very stable materials but are subject to photodechlorination when exposed to sunlight or UV (spectral region above 290 nanometers). Hazardous polymerization cannot occur. **Chemical Incompatibilities:** PCBs are chemically inert and resistant to oxidation, acids, and bases. **Conditions to Avoid:** Avoid heat and ignition sources.

Hazardous Products of Decomposition: Thermal oxidative decomposition [1112-1202 °F (600-650 °C)] of PCBs can produce highly toxic derivatives, including polychlorinated dibenzo-para-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), hydrogen chloride, phosgene and other irritants.

Section 6. Health Hazard Data

Carcinogenicity: The IARC⁽¹⁴⁴⁾ and NTP⁽¹⁶⁹⁾ list PCBs as an IARC probable carcinogen (overall evaluation is 2A; limited human data; sufficient animal data) and NTP anticipated carcinogen, respectively. **Summary of Risks:** PCBs are potent liver toxins that can be absorbed through unbroken skin in toxic amounts without immediate pain or irritation. PCBs have low acute toxicity, but can accumulate in fatty tissue and severe health effects may develop later. Generally, toxicity increases with a higher chlorine content; PCB-oxides are more toxic. The toxic action on the liver also increases with simultaneous exposure to other liver toxins, e.g. chlorinated solvents, alcohol, and certain drugs. Pathological pregnancies (abnormal pigmentations, abortions, stillbirths, and underweight births) have been associated with increased PCB serum levels in mothers; PCBs can be passed in breast milk. PCBs can affect the reproductive system of adults. **Medical Conditions Aggravated by Long-Term Exposure:** Skin, liver, and respiratory disease. **Target Organs:** Skin, liver, eyes, mucous membranes, and respiratory tract. **Primary Entry Routes:** Inhalation, dermal contact, ingestion. **Acute Effects:** Exposure to PCB vapor or mist is severely irritating to the skin, eyes, nose, throat, and upper respiratory tract. Intense acute exposure to high concentrations may result in eye, lung, and liver injury. Systemic effects include nausea, vomiting, increased blood pressure, fatigue, weight loss, jaundice, edema and abdominal pain. Cognitive, neurobehavior and psychomotor impairment and memory loss have also been seen after acute exposure. **Chronic Effects:** Repeated exposure to PCBs can cause chloroacne; redness, swelling, dryness, thickening and darkening of the skin and nails; swelling and burning of the eyes, and excessive eye discharge; distinctive hair follicles; gastrointestinal disturbances; neurological symptoms including headache, dizziness, depression, nervousness, numbness of the extremities, and joint and muscle pain; liver enlargement; menstrual changes in women; and chronic bronchitis. Cancer, primarily liver, is also a possible result of exposure, but data is inconclusive.

FIRST AID Eyes: Do not allow victim to rub or keep eyes tightly shut. Rinsing eyes with medical oil (olive, mineral) initially may remove PCB and halt irritation better than water rinsing alone. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. Skin: Quickly remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. Multiple soap and water washings are necessary. Avoid the use of organic solvents to clean the skin. For reddened or blistered skin, consult a physician. Inhalation: Remove exposed person to fresh air and support breathing as needed. Ingestion: In most cases, accidental PCB ingestion will not be recognized until long after vomiting would be of any value. Never give anything by mouth to an unconscious or convulsing person. Vomiting of the pure substance may cause aspiration. Consult a physician. Note to Physicians: Monitor patients for increased hepatic enzymes, chloroacne, and eye, gastrointestinal, and neurologic symptoms listed above. Diagnostic tests include blood levels of PCBs and altered liver enzymes.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, provide adequate ventilation, and isolate hazard area. Cleanup personnel should protect against vapor inhalation and skin or eye contact. For small spills, take up with sand or other noncombustible material and place into containers for later disposal. For larger spills, dike far ahead of spill to contain for later disposal. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** PCBs have been shown to bio-concentrate significantly in aquatic organisms. Ecotoxicity: Bluegill, TL₅₀: 0.278 ppm/96 hr. Mallard Duck, LD₅₀: 2000 ppm. **Environmental Degradation:** In general, the persistence of PCBs increases with an increase degree of chlorination. **Soil Absorption/Mobility:** PCBs are tightly absorbed in soil and generally do not leach significantly in most aqueous soil systems. However, in the presence of organic solvents, PCBs may leach rapidly through the soil. Volatilization of PCBs from soil may be slow, but over time may be significant. **Disposal:** Approved PCB disposal methods include: incineration with scrubbing, high-efficiency boilers, landfills, and EPA-approved alternative disposal methods. Each disposal method has various criteria. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

RCRA Hazardous Waste (40 CFR 261.33): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1 lb (0.454 kg) [* per CWA, Sec. 311(b)(4) and 307(a)]

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. Minimum respiratory protection should include a combination dust-fume-mist and organic vapor cartridge or canister or air-supplied, depending upon the situation. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. **Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.** If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent all skin contact. Butyl rubber, neoprene, Teflon, and fluorocarbon rubber have break through times greater than 8 hrs. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.⁽¹⁰³⁾ **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Segregate contaminated clothing in such a manner so that there is no direct contact by laundry personnel. Implement quality assurance to ascertain the completeness of the cleaning procedures. Remove this material from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in a closed, labelled, container in a ventilated area with appropriate air pollution control equipment. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. **Administrative Controls:** Inform employees of the adverse health effects associated with PCBs. Limit access to PCB work areas to authorized personnel. Consider preplacement and periodic medical examinations with emphasis on the skin, liver, lung, and reproductive system. Monitor PCB blood levels. Consider possible effects on the fetus. Keep medical records for the entire length of employment and for the following 30 yrs.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Polychlorinated biphenyls
DOT Hazard Class: 9
ID No.: UN2315
DOT Packing Group: II
DOT Label: CLASS 9

Packaging Authorizations
a) Exceptions: 173.155
b) Non-bulk Packaging: 173.202
c) Bulk Packaging: 173.241

Quantity Limitations
a) Passenger Aircraft or Railcar: 100 L
b) Cargo Aircraft Only: 220 L
Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: 34

Special Provisions (172.102): 9, N81

MSDS Collection References: 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 163, 164, 168, 169, 174, 175, 180
Prepared by: MJ Wurth, BS; **Industrial Hygiene Review:** PA Roy MPH, CIH; **Medical Review:** AC Darlington, MD

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Radioactive Material Safety Data Sheet

This data sheet presents information on radioisotopes only.

For information on chemical compounds incorporating this radionuclide, see the relevant Material Safety Data Sheet.

Strontium-90

Part 1 – Radioactive Material Identification

Common Names: Strontium-90

Chemical Symbol: Sr-90 or ^{90}Sr

Atomic Number: 38

Mass Number: 90 (52 neutrons)

Chemical Form: Strontium metal

Physical Form: A strontium compound incorporated on a ceramic insert or rolled silver foil.

Part 2 – Radiation Characteristics

Physical half-life: 28.6 years

Specific Activity (GBq/g): 5,050

Principle Emissions	E_{Max} (keV)	E_{eff} (keV)	Dose Rate (mSv/h/GBq at 1 m)	Shielding Required
Beta* (β)	546 (100%) 2,283 (99.9%) ^b	196 935	9.65 ^{a,c}	-
Gamma (γ) / X-Rays	-	-	-	-
Alpha (α)	-	-	-	-
Neutron (n)	-	-	-	-

* Where Beta radiation is present, Bremsstrahlung radiation will be produced. Shielding may be required.

Note: Only emissions with abundance greater than 10% are shown.

^a *The Health Physics and Radiological Health Handbook*, Scintra, Inc., Revised Edition, 1992

^b This beta is produced by the yttrium-90 progeny, which quickly comes into equilibrium with the strontium parent.

^c Total dose produced by strontium-90 in equilibrium with the yttrium-90 progeny.

Progeny: Yttrium-90 (Yt-90) {half-life: 64.4 hours; decay progeny: zirconium-90 (Zn-90)}

Part 3 – Detection and Measurement

Methods of detection (in order of preference)

1. A radiation survey meter equipped with a thin-window, energy-compensated Geiger Mueller detector.

2. A radiation contamination monitor equipped with a Geiger Mueller pancake detector.

3. A radiation survey meter equipped with a plastic scintillator detector.

Dosimetry

Whole Body ☐

Skin ☒

Extremity ☒

Neutron ☐

Internal: Sealed sources pose no internal radiation hazard. However, in the event of loss of containment by the sealed source, all precautions should be taken to prevent inhalation or ingestion of the material.

Critical Organ(s): Bone tissues

Annual dose limits: *Non-nuclear energy workers:* 1mSv per year
Nuclear energy workers: a) 50 mSv in one year
b) 100 mSv total over five years
Pregnant nuclear energy workers: 4 mSv over the balance of the pregnancy

Part 4 – Preventive Measures

Always use the principles of time, distance and shielding to minimize dose

Engineering Controls: Sealed radioactive sources used in industrial applications should always be within a protective source housing to minimize radiation dose and to protect the source capsule from damage.

Personal Protective Equipment (for normal handling of unsealed sources only. Always wear disposable gloves, safety glasses, personal protective equipment and clothing as appropriate to the material handled).
No special PPE required.

Special Storage Requirements: None

Part 5 – Control Levels

Oral Ingestion	Inhalation	
ALI (kBq)	ALI (kBq)	DAC (Bq/ml)
1,110	740	2.96×10^{-7}
Exemption Quantity (EQ):	10,000 Bq	

Part 6 – Non-Radiological Hazards

None identified at this time.

OSHA Permissible Exposure Limit (PEL)

No limits set at this time

Part 7 - Emergency Procedures

*The following is a guide for first responders. The following actions, including remediation, should be carried out by qualified individuals. In cases where life-threatening injury has resulted, **first** treat the injury, **second** deal with personal decontamination.*

Personal Decontamination Techniques

- Wash well with soap and water and monitor skin
- Do not abrade skin, only blot dry
- Decontamination of clothing and surfaces are covered under operating and emergency procedures

Spill and Leak Control

- Alert everyone in the area
- Confine the problem or emergency (includes the use of absorbent material)
- Clear area
- Summon Aid

Damage to Sealed Radioactive Source Holder

- Evacuate the immediate vicinity around the source holder
- Place a barrier at a safe distance from the source holder (min. 5 meters)
- Identify area as a radiation hazard
- Contact emergency number posted on local warning sign

Suggested Emergency Protective Equipment

- Gloves
- Footwear Covers
- Safety Glasses
- Outer layer or easily removed protective clothing (as situation requires)

Revision Date:

December 17, 2001

This information was compiled by:

Stuart Hunt & Associates Ltd.
20 Rayborn Crescent
St. Albert, Alberta
T8N 5C1
Phone: (780) 458-0291 or (800) 661-4591
Fax: (780) 459-0746
Web site: www.stuarthunt.com

Radioactive Material Safety Data Sheet

This data sheet presents information on radioisotopes only.

For information on chemical compounds incorporating this radionuclide, see the relevant Material Safety Data Sheet.

Cesium-137

Part 1 – Radioactive Material Identification

Common Names: Cesium-137

Chemical Symbol: Cs-137 or ^{137}Cs

Atomic Number: 55

Mass Number: 137 (82 neutrons)

Chemical Form: Cesium chloride

Physical Form: A pellet of cesium ceramic housed in a welded stainless steel capsule

Part 2 – Radiation Characteristics

Physical half-life: 30.22 years

Specific Activity (GBq/g): 3,220

Principle Emissions	E_{Max} (keV)	E_{eff} (keV)	Dose Rate ($\mu\text{Sv/h/GBq}$ at 1m)	Shielding Required
Beta* (β)	511 (94.6%)	157	-	-
Gamma (γ) / X-Rays	662 (89.9%)	-	103 ^a	HVL Lead: 0.65 cm
Alpha (α)	-	-	-	-
Neutron (n)	-	-	-	-

* Where Beta radiation is present, Bremsstrahlung radiation will be produced. Shielding may be required.

Note: Only emissions with abundance greater than 10% are shown.

^a The Health Physics and Radiological Health Handbook, Scintra, Inc., Revised Edition, 1992

Progeny: Barium-137m (Ba-137m)

Part 3 – Detection and Measurement

Methods of detection (in order of preference)

1. A radiation survey meter equipped with an energy-compensated Geiger Mueller detector.
2. Ion chamber survey meter – tends to be less sensitive than a Geiger Mueller survey meter but is able to respond more precisely in higher radiation fields.
3. Gamma scintillation detector – very sensitive but is also energy dependent. Must be calibrated for Cs-137 before it can be used for dose assessment surveys.

Dosimetry

Whole Body



Skin



Extremity



Neutron



Internal:

Sealed sources pose no internal radiation hazard. However, in the event of loss of containment by the sealed source, all precautions should be taken to prevent inhalation or ingestion of the material.

Critical Organ(s):

None known at this time.

Annual dose limits:

Non-nuclear energy workers: 1mSv per year

Nuclear energy workers: a) 50 mSv in one year

b) 100 mSv total over five years

Pregnant nuclear energy workers: 4 mSv over the balance of the pregnancy

Part 4 – Preventive Measures

Always use the principles of time, distance and shielding to minimize dose

Engineering Controls:

Sealed radioactive sources used in industrial applications should always be within a protective source housing to minimize radiation dose and to protect the source capsule from damage.

Personal Protective Equipment (*for normal handling of unsealed sources only. Always wear disposable gloves, safety glasses, personal protective equipment and clothing as appropriate to the material handled.*)
No special PPE required.

Special Storage Requirements: None

Part 5 – Control Levels

Oral Ingestion	Inhalation	
ALI (kBq)	ALI (kBq)	DAC (Bq/ml)
3700	7400	2.2×10^{-3}
Exemption Quantity (EQ):	10,000 Bq	

Part 6 – Non-Radiological Hazards

No potential health effects are known regarding non-radiological hazards associated with cesium. However, large oral doses of the material may cause gastrointestinal disturbances. Chronic effects are not known at this time.

OSHA Permissible Exposure Limit (PEL):

15 mg/m³ total dust, 5 mg/m³ respirable fraction for nuisance dusts

Part 7 - Emergency Procedures

The following is a guide for first responders. The following actions, including remediation, should be carried out by qualified individuals. In cases where life-threatening injury has resulted, first treat the injury, second deal with personal decontamination.

Personal Decontamination Techniques

- Wash well with soap and water and monitor skin
- Do not abrade skin, only blot dry
- Decontamination of clothing and surfaces are covered under operating and emergency procedures

Spill and Leak Control

- Alert everyone in the area
- Confine the problem or emergency (includes the use of absorbent material)
- Clear area
- Summon Aid

Damage to Sealed Radioactive Source Holder

- Evacuate the immediate vicinity around the source holder
- Place a barrier at a safe distance from the source holder (min. 5 meters)
- Identify area as a radiation hazard
- Contact emergency number posted on local warning sign

Suggested Emergency Protective Equipment

- Gloves
- Footwear Covers
- Safety Glasses
- Outer layer or easily removed protective clothing (as situation requires)

Revision Date:

December 17, 2001

This information was prepared by:

Stuart Hunt & Associates Ltd.
20 Raybom Crescent
St. Albert, Alberta
T8N 5C1
Phone: (780) 458-0291 or (800) 661-4591
Fax: (780) 459-0746
Web site: www.stuarthunt.com

Radioactive Material Safety Data Sheet

This data sheet presents information on radioisotopes only.

For information on chemical compounds incorporating this radionuclide, see the relevant Material Safety Data Sheet.

Radium-226

Part 1 – Radioactive Material Identification

Common Names: Radium-226

Chemical Symbol: Ra-226 or ^{226}Ra

Atomic Number: 88

Mass Number: 226 (138 neutrons)

Chemical Form: Radium bromide or
radium chloride

Physical Form: A pellet or solution housed within a
ceramic outer-housing.

Part 2 – Radiation Characteristics

Physical half-life: 1,603 years

Specific Activity (GBq/g): 36.6

Principle Emissions	E _{Max} (keV)	E _{eff} (keV)	Dose Rate (μSv/h/GBq at 1m)	Shielding Required
Beta* (β)	-	-	-	-
Gamma (γ) / X-Rays	186 (32.8%)	-	3.3 ^a	HVL Lead: 0.04 cm
Alpha (α)	4,785 (94.6%)	-	-	-
Neutron (n)	-	-	-	-

* Where Beta radiation is present, Bremsstrahlung radiation will be produced. Shielding may be required.

Note: Only emissions with abundance greater than 10% are shown.

^a The Health Physics and Radiological Health Handbook, Scintra, Inc., Revised Edition, 1992

Progeny: Radon-222 (Ra-222)

Part 3 – Detection and Measurement

Methods of detection (in order of preference)

1. A radiation survey meter equipped with an energy-compensated Geiger Mueller detector.

2. A radiation contamination monitor equipped with a Geiger-Mueller pancake detector.

3. An ZnS(Ag) alpha scintillation detector – must be calibrated to a radium-226 standard before used for a dose assessment survey.

Dosimetry

Whole Body	<input checked="" type="checkbox"/>	Skin	<input type="checkbox"/>	Extremity	<input type="checkbox"/>	Neutron	<input type="checkbox"/>
Internal:		Sealed sources pose no internal radiation hazard. However, in the event of loss of containment by the sealed source, all precautions should be taken to prevent inhalation or ingestion of the material.					
Critical Organ(s):		Bone tissue					
Annual dose limits:		<p><i>Non-nuclear energy workers:</i> 1mSv per year</p> <p><i>Nuclear energy workers:</i> a) 50 mSv in one year b) 100 mSv total over five years</p> <p><i>Pregnant nuclear energy workers:</i> 4 mSv over the balance of the pregnancy</p>					

Part 4 – Preventive Measures

Always use the principles of time, distance and shielding to minimize dose

Engineering Controls:	Sealed radioactive sources used in industrial applications should always be within a protective source housing to minimize radiation dose and to protect the source capsule from damage.
Personal Protective Equipment	<i>(for normal handling of unsealed sources only. Always wear disposable gloves, safety glasses, personal protective equipment and clothing as appropriate to the material handled).</i> No special PPE required.
Special Storage Requirements:	None

Part 5 – Control Levels

Oral Ingestion	Inhalation	
ALI (kBq)	ALI (kBq)	DAC (Bq/ml)
74	22.2	1.11×10^{-5}
Exemption Quantity (EQ):	10,000 Bq	

Part 6 – Non-Radiological Hazards

<p>None identified at this time.</p> <p><u>OSHA Permissible Exposure Limit (PEL)</u></p> <p>No limit set at this time</p>

Part 7 - Emergency Procedures

The following is a guide for first responders. The following actions, including remediation, should be carried out by qualified individuals. In cases where life-threatening injury has resulted, first treat the injury, second deal with personal decontamination.

Personal Decontamination Techniques

- Wash well with soap and water and monitor skin
- Do not abrade skin, only blot dry
- Decontamination of clothing and surfaces are covered under operating and emergency procedures

Spill and Leak Control

- Alert everyone in the area
- Confine the problem or emergency (includes the use of absorbent material)
- Clear area
- Summon Aid

Damage to Sealed Radioactive Source Holder

- Evacuate the immediate vicinity around the source holder
- Place a barrier at a safe distance from the source holder (min. 5 meters)
- Identify area as a radiation hazard
- Contact emergency number posted on local warning sign

Suggested Emergency Protective Equipment

- Gloves
- Footwear Covers
- Safety Glasses
- Outer layer or easily removed protective clothing (as situation requires)

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Stuart Hunt & Associates Ltd.
20 Rayborn Crescent
St. Albert, Alberta
T8N 5C1

Phone: (780) 458-0291 or (800) 661-4591

Fax: (780) 459-0746

Web site: www.stuarthunt.com



Genium Publishing Corp.

One Genium Plaza
Schenectady, NY 12304-4690
(518) 377-8854

Material Safety Data Sheet Collection

Silver

MSDS No. 181

Date of Preparation: 4/86

Revision: A, 6/94

Section 1 - Chemical Product and Company Identification

44

Product/Chemical Name: Silver

Chemical Formula: Ag

CAS No.: 7440-22-4

Synonyms: argentum

Derivation: Occurs naturally in sea water (0.01 ppm) and the earth's crust (0.1 ppm). Silver containing ores include argentite, stephanite, polybasite, proustite, pyrargyrite, and cerargyrite. Extraction of silver is essentially as a by-product of copper, lead, or zinc extraction and this accounts for 3/4 of its production. The two main production methods are *slime melting* from electrolytic refining of copper and the *Parkes process* from lead and zinc ores.

General Use: Used in the manufacture of jewelry, tableware, ornaments, mirrors, electrical contacts, batteries, solder; in photography, dental amalgams; as a sterilant, for water purification, and as a coating for the inside of light bulbs (sandwiched between two layers of titanium oxide).

Vendors: Consult the latest *Chemical Week Buyers' Guide*. (73)

Section 2 - Composition / Information on Ingredients

Silver, ca 100 % wt. 97.5 % silver + 2.5 % copper = *sterling silver*.

OSHA PEL

8-hr TWA: 0.01 mg/m³

ACGIH TLV

TWA: 0.1 mg/m³

NIOSH REL

10-hr TWA: 0.01 mg/m³

DFG (Germany) MAK

TWA: 0.01 mg/m³ (total dust)

Category III: Substances with systemic effects

Onset of Effect: > 2 hr

Half-life: > shift length (strongly cumulative)

Peak Exposure Limit:

0.1 mg/m³, 30 min. average value, 1/shift

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Silver exists as a hard, brilliant white, malleable metal. It is noncombustible as a solid, but the finely divided powder is flammable. Silver has no known function in man and appears to have low toxicity other than a localized or general bluish-gray pigmentation of the mucous membranes, eyes, and skin due to deposition of silver particles over a period of time. The condition called *argyria* appears to be more of a cosmetic problem than a toxicological concern.

Potential Health Effects

Primary Entry Routes: Inhalation, skin and eye contact.

Target Organs: Skin, eyes (especially the conjunctiva), and mucous membranes.

Acute Effects

Inhalation: Heavy exposure of a worker to heated metallic silver vapor for 4 hr caused lung damage and pulmonary edema (fluid in lungs). Diffuse pulmonary fibrosis is also possible.

Eye and Skin: Effects are generally chronic.

Carcinogenicity: IARC, NTP, and OSHA do not list silver as a carcinogen.

Medical Conditions Aggravated by Long-Term Exposure: None reported.

Chronic Effects: The main effect associated with exposure to silver is argyria, a bluish-gray pigmentation of the eyes, skin, and mucous membranes caused by deposition of silver particles. This effect can be either local or generalized. It appears that localized deposition occurs by penetration of fine, metallic particles and that generalized argyria occurs from inhalation or ingestion of silver salts. It is estimated that a gradual intake of 1 to 5g silver will lead to generalized argyria. Generalized argyria appears to be darker in areas exposed to the light. Silver deposition in the respiratory tract may result in a mild chronic bronchitis. Silver polishers exposed for long periods to silver and polishing dusts have developed increased lung densities (shown by x-ray). Argyria of the eyes is not accompanied by vision loss although there may be some difficulty adapting to the dark. There is some evidence for skin absorption; amalgam tattoos (accidental implantation of dental amalgams) caused fatigue, headache, sinusitis, and weight loss. Repeated skin contact may cause allergic contact dermatitis in some individuals.

Other: The reason that silver toxicity rarely occurs beyond argyria is due to rapid binding to various proteins and precipitation of silver chloride. Tissue damage only occurs when this binding ability is altered by a heavy dose. Kidney, liver, and neurologic damage has been associated with silver, but these cases are not well documented.

Wilson Risk Scale

R 1
I 4
S 1
K 0

HMIS

H 1*
F 0
R 0

*Chronic effects

PPE †

†Sec. 8

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin Contact: *Quickly* remove contaminated clothing. Rinse away loose material and move quickly to a soap and water wash.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Silver deposited in tissues is relatively inert and does not respond well to chelation therapy. There is no known treatment for argyria. Background serum levels of silver vary widely: 0.004 mcg/g to 0.03 mcg/g of blood. Discoloration of Descemet's membrane is the most sensitive indicator of chronic exposure to silver. Background excretion is 8 to 28 nmol/L. In one study, the urinary enzyme, N-acetyl- β -D glucosaminidase was significantly elevated and correlated with blood silver concentrations and age. It may be an indicator of exposure.

Section 5 - Fire-Fighting Measures

Flash Point: Noncombustible as the solid.

Autoignition Temperature: None reported.

LEL: None reported.

UEL: None reported.

Extinguishing Media: Use agents suitable for surrounding fire.

Unusual Fire or Explosion Hazards: None reported.

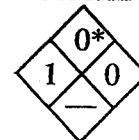
Hazardous Combustion Products: Silver fumes.

Fire-Fighting Instructions: Do not release runoff from fire control methods to sewers or waterways.

Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode.

* Flammable when in highly divided powder form.

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Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel, isolate and ventilate area. Cleanup personnel should protect against inhalation and skin/eye contact with dusts.

Spills: Carefully scoop up spill and place in sealed containers for reclamation.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Wear appropriate PPE to avoid inhalation or skin/eye contact with silver dusts.

Storage Requirements: Store in a cool, dry, well-ventilated area away from incompatibles (Sec. 10).

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: No special controls needed.

Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source. (103)

Administrative Controls: Consider preplacement and periodic medical exams of exposed workers with emphasis on the skin, eyes, and mucous membranes (for presence of argyria).

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For $\leq 0.25 \text{ mg/m}^3$, use any supplied-air respirator (SAR) operated in continuous-flow mode or any powered, air-purifying respirator with a high-efficiency particulate filter. Use eye protection when necessary. For $\leq 0.5 \text{ mg/m}^3$, use any high-efficiency particulate filter respirator with a full facepiece, any SCBA with a full facepiece, or any SAR with a full facepiece. For $\leq 20 \text{ mg/m}^3$, use any SCBA or SAR (with auxiliary SCBA) with a full facepiece and operated in pressure demand or other positive pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Protective Clothing/Equipment: Wear protective gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.

Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.

Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove silver from your shoes and clean personal protective equipment. *Do not* shake dust off contaminated clothing; vacuum with a HEPA filter.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using silver, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Solid

Appearance and Odor: Hard, brilliant white, lustrous, ductile, malleable metal; odorless.

Vapor Pressure: 0 mm Hg at 77 °F (25 °C), 100 mm Hg at 3389 °F (1865 °C)

Atomic Weight: 107.868

Density: 10.5 g/mL

Thermal Conductivity: 101 cal/cm/sec/°C

Water Solubility: Insoluble

Other Solubilities: Insoluble in most cold acids except dilute nitric acid. Reacts with hot, concentrated sulfuric acid. Soluble in fused alkali hydroxides in the presence of air, fused alkali peroxides, and in alkali cyanides in presence of air or oxygen.

Boiling Point: 4013 °F (2212 °C)

Melting Point: 1763 °F (961 °C)

Section 10 - Stability and Reactivity

Stability: Silver is stable at room temperature in closed containers under normal storage and handling conditions.

Polymerization: Hazardous polymerization does not occur.

Chemical Incompatibilities: Include acetylene and acetylenic compounds (forms explosive silver acetylides), aziridine, bromine azide, 3-bromopropyne, carboxylic acids, copper + ethylene glycol, electrolytes + zinc, ethanol + nitric acid, ethylene oxide, ethyl hydroperoxide, iodoform, ethyleneimine, peroxomonosulfuric acid, and peroxyformic acid. Silver is flammable by chemical reaction with ammonia, chlorine trifluoride, ethylene imine, hydrogen peroxide, oxalic acid, and tartaric acid. It turns black (tarnishes) on contact with ozone, sulfur, or hydrogen sulfide.

Conditions to Avoid: Contact with incompatibles.

Hazardous Decomposition Products: Silver fumes will be given off when heated.

Section 11 - Toxicological Information

Toxicity Data:*

Carcinogenicity: Rat, multiple routes: 330 mg/kg/43 weeks (intermittently) caused tumors at site of application.

* See NIOSH, RTECS (VW3500000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: Sticklebacks, LD₅₀ = 0.004 mg/L/168 hr; sticklebacks, LD₅₀ = 0.1 mg/L/24 hr. Although silver accumulates in body tissue it does not appear to bioaccumulate through the food chain (no magnification at higher trophic levels).

Environmental Degradation: In water, silver will undergo absorption by manganese dioxide and precipitation with halides.

Section 13 - Disposal Considerations

Disposal: Return silver and silver-containing solutions from photography and x-rays to supplier for reclamation. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101): Not listed

Shipping Name:

Environmentally hazardous substances, solid, n.o.s.*

Shipping Symbols: —

Hazard Class: 9

ID No.: UN3077

Packing Group: III

Label: Class 9

Special Provisions (172.102): 8, B54, N50

Packaging Authorizations

a) **Exceptions:** 173.155

b) **Non-bulk Packaging:** 173.213

c) **Bulk Packaging:** 173.240

Quantity Limitations

a) **Passenger, Aircraft, or Railcar:** None

b) **Cargo Aircraft Only:** None

Vessel Stowage Requirements

a) **Vessel Stowage:** A

b) **Other:** —

* Classified as a hazardous substance when silver is in a quantity, in one package, which equals or exceeds the RQ of 1000 lb (454 kg)

Section 15 - Regulatory Information

EPA Regulations:

RCRA Hazardous Waste Classification (40 CFR 261.24): D011, Characteristic of Toxicity (regulatory level = 5 mg/L)

Listed as a CERCLA Hazardous Substance (40 CFR 302.4) per CWA, Sec. 307(a)

CERCLA Reportable Quantity (RQ), 1000 lb (454 kg)

Listed as a SARA Toxic Chemical (40 CFR 372.65)

SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed

OSHA Regulations:

Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A): Not listed

Section 16 - Other Information**References:** 73, 103, 124, 132, 136, 148, 149, 167, 176, 187, 189**Prepared By** M Gannon, BA**Industrial Hygiene Review** RE Langford, PhD, CIH**Medical Review** T Thoburn, MD, MPH

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One Genium Plaza
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(518) 377-8854

Material Safety Data Sheet Collection

Strontium Carbonate

MSDS No. 120

Date of Preparation: 10/83

Revision: B 10/96

Section 1 - Chemical Product and Company Identification

48

Product/Chemical Name: Strontium carbonate

Chemical Formula: SrCO_3

CAS Number: 1633-05-2

Synonyms: carbonic acid, strontium salt; strontianite

Derivation: Celestite ore is boiled with a solution of ammonium carbonate or is fused with sodium carbonate.

General Use: Used in pyrotechnics, manufacture of iridescent glass, refining sugar, manufacture of ceramic ferrites, glass face plates for color TV tubes; as a chemical intermediate for strontium nitrate, lead scavenger in zinc production, and as flux in production of high-grade alloy steels.

Vendors: Consult the latest *Chemical Week Buyers' Guide*. (73)

Section 2 - Composition / Information on Ingredients

Strontium carbonate, ca > 99 % wt

Trace Impurities: May contain trace amounts of barium carbonate, sulfur, calcium carbonate, magnesium, sodium, silica, or iron.

OSHA PEL*

8-hr TWA: 15 mg/m^3 (total dust); 5 mg/m^3 (respirable fraction)

ACGIH TLV*

TWA: 10 mg/m^3 †

NIOSH REL

None established

DFG (Germany) MAK

None established

* As nuisance particulates (not otherwise classified)

† Notice of intended change to 10 mg/m^3 (inhalable) and 3 mg/m^3 (respirable)

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Strontium carbonate exists as a colorless to white, odorless powder. It has very low order of toxicity due to its poor absorption via the respiratory and gastrointestinal tracts. Ingestion of large amounts may cause nausea and vomiting. It is noncombustible.

Potential Health Effects

Primary Entry Routes: Inhalation, ingestion.

Target Organs: Gastrointestinal tract, teeth; and bones (animals).

Acute Effects

Inhalation: May cause mechanical irritation of the respiratory tract.

Eye: May cause mechanical irritation.

Skin: May cause mechanical irritation.

Ingestion: Ingestion of large amounts may cause excessive salivation, nausea, vomiting, diarrhea and colic.

Carcinogenicity: IARC, NTP, and OSHA do not list strontium carbonate as a carcinogen.

Medical Conditions Aggravated by Long-Term Exposure: None reported.

Chronic Effects: Strontium in drinking water (13 mg/L) has been shown to cause mineralization of bones and teeth in 1 yr olds. It is not known whether deposition in teeth and bone could be a potential hazard from industrial exposure. Animals chronically exposed to strontium have developed strontium "rickets" (malformation of bone during growth from failure to use calcium and phosphorus normally). Workers in strontium salt plants were reported with decreased cholinesterase activity levels. (190)

**Wilson
Risk
Scale**
R 1
I 1
S 1
K 1

HMIS
H 1
F 0
R 0
PPE*
*Sec. 8

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Eye Contact: Do not allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with plenty of water. Consult a physician or ophthalmologist immediately.

Skin Contact: Quickly remove contaminated clothing. Rinse with flooding amounts of water followed by a thorough soap and water wash. For reddened or blistered skin, consult a physician.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the conscious and alert person drink 1 to 2 glasses of water, then induce vomiting.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Treatment is symptomatic and supportive.

Section 5 - Fire-Fighting Measures

Flash Point: Noncombustible.

Autoignition Temperature: None reported.

LEL: None reported.

UEL: None reported.

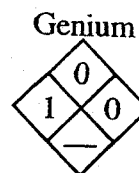
Extinguishing Media: Use agents suitable for surrounding fire.

Unusual Fire or Explosion Hazards: None reported.

Hazardous Combustion Products: Carbon dioxide and strontium oxide.

Fire-Fighting Instructions: Do not release runoff from fire control methods to sewers or waterways.

Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode.

**Section 6 - Accidental Release Measures**

Spill/Leak Procedures: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind.

Small Spills: Carefully scoop up or vacuum (with HEPA filter) and place in suitable containers.

Large Spills

Containment: For large spills, dike far ahead of liquid spill for later disposal. Do not release into sewers or waterways.

Cleanup: Damp mop any residue.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Use sufficient ventilation to prevent build-up dusts. Cleanup personnel should protect against inhalation.

Storage Requirements: Store in a cool, dry, well-ventilated area away from heat sources.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: No special engineering controls are necessary.

Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2) for nuisance dusts. Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source. (103)

Administrative Controls: No specific controls recommended.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.

Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.

Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove strontium carbonate from your shoes and clean personal protective equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using strontium carbonate, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Solid

Appearance and Odor: Colorless to white powder, odorless.

Formula Weight: 147.64

Density (H₂O=1, at 4 °C): 3.5 g/cm³

Water Solubility: 11 g/L at 18 °C

Other Solubilities: Soluble in dilute acids and ammonium salts.

Melting Point: 2727 °F (1497 °C) at 69 atm; decomposes at 2012 °F (1100 °C) into strontium oxide and carbon dioxide.

Refractive Index: 1.516, 1.664, 1.666

Section 10 - Stability and Reactivity

Stability: Strontium carbonate is stable at room temperature in closed containers under normal storage and handling conditions.

Polymerization: Hazardous polymerization does not occur.

Chemical Incompatibilities: None reported.

Conditions to Avoid: Excessive heat.

Hazardous Decomposition Products: Thermal oxidative decomposition (at 1100 °C) of strontium carbonate can produce carbon dioxide and strontium oxide.

Section 11 - Toxicological Information

Toxicity Data: Not listed by RTECS*

* Monitor NIOSH, RTECS for future toxicity data.

Section 12 - Ecological Information

Ecotoxicity: Data not found.

Environmental Fate: Data not found.

Section 13 - Disposal Considerations

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101): Not listed

Section 15 - Regulatory Information

EPA Regulations:

RCRA Hazardous Waste (40 CFR 261.33): Not listed

CERCLA Hazardous Substance (40 CFR 302.4): Not listed

SARA Toxic Chemical (40 CFR 372.65): Not listed

SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed

OSHA Regulations:

Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A): Not listed

Section 16 - Other Information

References: 73, 103, 124, 136, 190, 197, 209

Prepared ByM Gannon, BA

Industrial Hygiene ReviewPA Roy, MPH, CIH

Medical ReviewR Teichman, MD

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One Genium Plaza
Schenectady, NY 12304-4690 USA
(518) 377-8854

Sheet No. 124
Vanadium Metal/Powder

Issued: 10/83

Revision: A, 11/90

Section 1. Material Identification

Vanadium Metal/Powder (V) Description: Occurs ubiquitously in the earth's crust. Its principle ores are patronite, roscelite, carnotite, and vanadinite. There are more than 65 different vanadium-containing ores. Also found in crude petroleum, in flue-gas deposits from oil-fired furnaces, or in slags from ferrovanadium production. Vanadium production includes roasting ores and electrolytic refining using a molten salt electrolyte containing vanadium chloride. Used to manufacture rust-resistant vanadium steel, alloy steels, vanadium compounds; as a target material for x-rays; and as a catalyst for sulfuric acid and synthetic rubber.

Other Designations: CAS No. 7440-62-2

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*⁽⁷³⁾ for a suppliers list.

Cautions: Vanadium is a primary irritant of the mucous membranes of the respiratory tract and the conjunctiva (eye).

R 0
I 4
S 1
K 0

Genium



HMS
H 2
F 0
R 0
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Vanadium, ca 100%

1989 OSHA PEL

Vanadium, as V_2O_5 ,
Respirable Dust and Fume
8-hr TWA: 0.05 mg/m³

1990-91 ACGIH TLV

Vanadium, as V_2O_5 ,
Respirable Dust and Fume
TWA: 0.05 mg/m³

1985-86 Toxicity Data*

Human, inhalation, TD_{Lo} : 4 µg/kg; affected the lungs, thorax, or respiration (sputum, cough); and sense organs and special senses (changes in circulation)

1987 IDLH Level

Vanadium Pentoxide Dust
or Fume (as V)
70 mg/m³

1988 NIOSH REL

Vanadium, as V_2O_5 ,
Respirable Dust and Fume
15-min Ceiling: 0.05 mg/m³

* Monitor NIOSH, RTECS (YW1630000), for future toxicity data.

Section 3. Physical Data

Boiling Point: 6116 °F (3380 °C)

Melting Point: 3434 + 10 °F (1890 + 10 °C)

Vapor Pressure: 1.5 mm Hg at 4172 °F (2300 °C)

Atomic Weight: 50.92

Specific Gravity: 5.96

Water Solubility: Insoluble in hot or cold water

Appearance and Odor: Light gray powder or white, lustrous bulk solid; no odor.

Section 4. Fire and Explosion Data

Flash Point: None reported

Autoignition Temperature: * layer 914 °F (490 °C),
cloud 932 °F (500 °C)

LEL: 0.22 oz/ft³*

UEL: None reported

Extinguishing Media: Use dry chemical powder or CO₂ to extinguish a metal fire.

Unusual Fire or Explosion Hazards: Very hot vanadium can burn in air. When dispersed in air as dust, it can be exploded by an ignition source.* However, it has a low explosibility index (0.1) and low ignition sensitivity (0.3) on a scale of 10.

Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective gear. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

* Vanadium metal dust whose particle size is 100% below 75 µm. Reported minimum ignition energy is 60 mJ for dust cloud.

Section 5. Reactivity Data

Stability/Polymerization: Vanadium is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur. Massive metal is relatively inert to O₂, N₂, H₂, and H₂O at ambient conditions, but vanadium reacts when heated, and still more readily if powdered. When heated in air, vanadium oxidizes to brownish-black trioxide, blue-black tetroxide or yellow-red pentoxide, depending on temperature.

Chemical Incompatibilities: Vanadium is incompatible with bromine trifluoride, chlorine, nitryl fluoride, lithium, and oxidants. Some samples of vanadium prepared by magnesium reduction of vanadium dichloride or vanadium trichloride are pyrophoric (ignite spontaneously).

Conditions to Avoid: Avoid creating airborne dusty conditions.

Hazardous Products of Decomposition: Thermal oxidative decomposition of vanadium can produce toxic fumes of vanadium oxides (VO_x).

Section 6. Hazard Data

Carcinogenicity: The NTP, IARC, and OSHA do not list vanadium metal powder as a carcinogen.

Summary of Risks: Elemental vanadium is considered relatively nontoxic and the risks noted in mining operations are usually limited. However, toxic vanadium compounds form easily with the addition of heat, and may be present in many occupational settings. Vanadium compounds are very irritating to mucous membranes including the respiratory tract. Although no specific lesions are noted, inflammation of all portions of the airways, as well as pulmonary edema, pneumonia, and emphysema are described. The presence of vanadium compounds in areas where residues from the burning of fuel oil may accumulate presents particular problems with unrecognized risk.

Medical Conditions Aggravated by Long-Term Exposure: No permanent effects are reported, but respiratory symptoms may persist for years.

Target Organs: Respiratory system, skin, and eyes.

Primary Entry Routes: Inhalation, ingestion.

Acute Effects: *Skin:* eczema-like reaction with intense itching. Sensitization or generalized hives may occur. Green discoloration of the hands and groin area is noted. *Eyes:* severe irritation with burning and tearing may occur. *Airway:* nasal congestion, throat irritation, dry mouth, green discoloration of the tongue, metallic taste, coughing, bronchitis, pneumonia, chest pain, and pulmonary edema are noted. *Cardiovascular:* constriction of blood supply to the lungs, spleen, kidneys, and intestines. *CNS:* headaches, decreased concentration in severe exposures. *GI:* diarrhea, black stools, cramping.

Chronic Effects: The lung effects may last up to two weeks following exposure. Skin and tongue discoloration may develop gradually.

FIRST AID

Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin: Quickly remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that conscious person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Notes to Physician: Include diagnostic tests such as vanadium in urine (normal <1 µg/g creatine), patch (eczema), and pulmonary function (FEV₁ and FVC).

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel and provide adequate ventilation. Cleanup personnel should protect against dust inhalation and skin or eye contact. Follow applicable OSHA regulations (29 CFR 1910.120).

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

RCRA Hazardous Waste (40 CFR 261.33): Not listed

CERCLA Hazardous Substance (40 CFR 302.4): Not listed

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For concentrations less than or equal to 70 mg/m³, use a powered air-purifying respirator with full facepiece and high-efficiency particulate filter. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks) or concentrations >70 mg/m³, wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact.

Ventilation: Provide general and local ventilation systems to maintain airborne concentrations just below the exposure limits (Sec. 2). Exhaust ventilation systems discharging to outside air must conform with applicable local, state, and federal air pollution regulations. Ventilation systems need to be cleaned and their effectiveness tested with airflow measurements taken at least every 3 months. Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.⁽¹⁰³⁾

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in closed containers in a cool, dry, well-ventilated area. Protect containers from damage. Use good housekeeping practices to prevent accumulation of dust and follow cleaning techniques that minimize airborne particulate.

Engineering Controls: Avoid dust, vapor, or fume inhalation when generated. Prevent contact with eyes and skin. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good personal hygiene and housekeeping procedures.

Other Precautions: Provide preplacement and periodical medical examinations that emphasize the eyes, skin, and lungs. For biological monitoring of exposed workers use urinary vanadium excretion. Include pulmonary function tests in periodical medical examinations.

Transportation Data (49 CFR 172.101, .102): Not listed

MSDS Collection References: 2-10, 12, 14, 20, 26, 40, 41, 73, 84, 88, 89, 100, 101, 103, 109, 124, 126, 127, 132, 133, 136, 138, 139, 140, 143, 146
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD; **Edited by:** JR Stuart, MS

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Material Safety Data Sheets Collection:

Sheet No. 73
Zinc Metal/Powder

Issued: 7/80

Revision: A, 11/89

Section 1. Material Identification

30

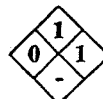
Zinc Metal/Powder Description: A metallic element extracted from ores which are first roasted to form zinc oxide and then: 1) the zinc oxide is leached from the roasted material with sulfuric acid to form a zinc sulfate solution which is electrolyzed in cells to deposit zinc on cathodes and 2) the zinc oxide is reduced with carbon in retorts (distilling vessels) to yield distilled and condensed zinc. Used as ingredient in alloys such as brass, bronze, and die-casting alloys; galvanizing sheet iron; for electrical apparatus, especially castings, building materials, dry cell batteries, automotive equipment, household utensils, railroad car linings; as a fungicide; in nutrition (essential growth element); as reagent in analytical chemistry; in bleaching bone glue, manufacturing sodium hydrosulfite, and insulin zinc salts.

Other Designations: Blue powder; spelter; granular zinc; jasad; merrillite; pasco; Zn; CAS No. 7440-66-6.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.

R 1
I 1
S 1
K 1

NFPA



HMIS

H 0

F 1

R 1

PPG*

* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Zinc metal/powder, ca 99%

OSHA PEL

None established*

ACGIH TLV, 1989-90

None established*

NIOSH REL, 1987

None established*

Toxicity Data†

Human, inhalation, TC_{50} : 124 mg/m³/50 min, pulmonary system effects

* The current OSHA standard and ACGIH (1989-1990) TWA for zinc oxide (ZnO) fumes is 5 mg/m³. The ACGIH TWA for zinc oxide dust is 10 mg/m³, providing that total contains no asbestos and is <1% crystalline silica. NIOSH has recommended a 10-hr TWA of 5 mg/m³ and a ceiling level of 15 mg/m³ (15-min sample) for zinc oxide fume. The TLV-TWA level was set to prevent metal fume fever.

† See NIOSH, *RTECS* (ZG8600000), for additional data with references to irritative effects.

Section 3. Physical Data

Boiling Point: 907 °F (1663 °C)

Atomic Weight: 65.37 g/mol

Melting Point: 419 °F (787 °C)

Specific Gravity ($H_2O = 1$ at 39 °F (4 °C)): 7.13 at 77 °F (25 °C)

Vapor Pressure: 1 mm Hg at 909 °F (487 °C)

Water Solubility: Insoluble

Brinell Hardness: 31

Index of Explosibility, Zn Powder (<0.1 weak, >10 severe): 0.1

Appearance and Odor: Bluish-white lustrous metal, also finely divided forms.

Section 4. Fire and Explosion Data

Flash Point: None reported **Autoignition Temperature:** Cloud, 1256 °F (680 °C);* dust layer, LEL: Dust cloud explosion, UEL: None reported
860 °F (460 °C);* powder, 650 mJ* 0.5 oz/ft³

Extinguishing Media: Use special dry chemical or clean dry sand. *Never* use CO₂. Using a direct stream of water may scatter the fire or disperse dust, creating a potentially explosive mixture if exposed to heat or ignition sources. A water spray may be used to cool fire-exposed containers and disperse vapors.

Unusual Fire or Explosion Hazards: Flammable hydrogen gas is liberated by reaction with alkali hydroxides (sodium, potassium, and calcium hydroxides), acids, or even water (when material is in dust form) and is an explosion hazard in a confined space. In a fire, zinc may melt, vaporize, and burn to form ZnO fumes (Sec. 2).

Special Fire-fighting Procedures: For major fires, or if large quantities of this material are involved, fire fighters should wear appropriate protective clothing and respiratory protection. Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

* Zinc dust refers to the product of zinc vapor condensation, and zinc powder to the product of molten zinc atomization (*Zinc Dust and Zinc Powder: Their Production, Properties, and Applications*, B.C. Hafford, W.E. Pepper, and T.B. Lloyd, 1982). Dust 100% thru 74- μ m sieve; a 0.96-J spark can ignite a cloud. The ignition temperature in CO₂ is 896 °F (480 °C). The reaction temperature in a nitrogen atmosphere is 1112 °F (600 °C).

Section 5. Reactivity Data

Stability/Polymerization: Zinc is stable in dry air at room temperature. Moist zinc dust can react exothermically and ignite spontaneously in air. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Zinc dust is an explosion hazard when reacted with acids, chlorates, oxidizing agents (sulfur and oxygen), halogenated hydrocarbons, hydrazine mononitrate, hydroxylamine, ammonium nitrate, barium dioxide, barium nitrate, cadmium, performic acid, manganese chloride, nitric acid, ethyl acetate and tribromoneopentyl alcohol, tellurium, carbon disulfide, lead azide, magnesium and barium nitrate and barium dioxide, selenium, sodium peroxide, potassium nitrate, and water. In humans, a toxic effect results from inhaling 124 mg/m³ of zinc metal/powder for 50 min.

Hazardous Products of Decomposition: Thermal oxidative decomposition of zinc can produce highly toxic fumes. Above 999 °F (537 °C) vaporized zinc burns in air with a blue-green flame to produce zinc oxide fumes.

Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists zinc as a carcinogen.

Summary of Risks: Zinc is relatively nontoxic, but when combined with other materials such as oxygen or mineral acids, the resulting compounds can have toxic effects. It is not readily absorbed through the skin, gastrointestinal (GI) tract, or lungs. Although most inorganic zinc compounds are potential causes of gastroenteric irritation, a high-level dose is relatively nontoxic when ingested. Zinc is considered essential to life. Ingestion of soluble salts may cause nausea and vomiting, sluggishness, and light-headedness. Inhalation of zinc fumes normally generated by zinc and extreme heat may cause *metal fume fever*, which is accompanied by throat dryness and irritation, coughing, weakness, dyspnea, and generalized aching that generally passes within 24 hr. These symptoms usually begin 3 to 10 hr after exposure and resolve within 24 to 48 hr. Inhalation of zinc dust may cause mild irritation to the upper respiratory tract. Prolonged skin contact with zinc may cause a mild, drying dermatitis.

Medical Conditions Aggravated by Long-Term Exposure: Since metallic zinc particulates can be considered a nuisance dust, repeated inhalation of zinc dust could lead to respiratory complications.

Target Organs: Respiratory system.

Primary Entry: Inhalation, ingestion.

Acute Effects: Metal fume fever is an acute, self-limiting condition, without recognized complications, aftereffects, or chronic forms. Symptoms appear several hours after exposure. Removal from exposure normally alleviates symptoms with no residual or chronic effects. A degree of tolerance may result from continued exposure, but is quickly lost after a day or two of nonexposure.

Chronic Effects: Zinc and zinc powder have little history of causing chronic effects.

FIRST AID

Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.

Skin: After rinsing affected area with flooding amounts of water, wash it with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that conscious person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear. **Physician's Note:** Calcium disodium edetate ($\text{CaNa}_2\text{-EDTA}$) has been used medically to increase the rate of zinc removal from the body; however, this usually results from chronic fume exposure or exposure to zinc salts, not to zinc metal powders.

After first aid, get appropriate in-plant, paramedic, or community medical attention and support.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of powder spills. Eliminate all heat and ignition sources. Cleanup personnel should protect against dust inhalation and eye contact. Use nonsparking tools for cleanup. Sweep or otherwise place the spilled material in an appropriate, pressure-vented, dry-metal container (with lid) for later disposal. Container should be pressure vented. Avoid creating airborne dust conditions.

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

OSHA Designations

Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

EPA Designations

RCRA Hazardous Waste (40 CFR 261.33): Not listed

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1000 lb (454 kg) [* per Clean Water Act, Sec. 307(a)]

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

Zinc (fume or dust) is listed as SARA Toxic Chemical (40 CFR 372.65)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: For zinc oxide dust or fume concentrations up to 50 mg/m³ and 250 mg/m³, use, respectively, a fume (high-efficiency particulate) respirator or an air-supplied or self-contained respirator with a full facepiece. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.

Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact.

Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below established TLVs-TWAs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103).

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing. Remove this material from your shoes and equipment. Wash thoroughly before changing to street clothes.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in covered metal containers in a dry, well-ventilated, low fire risk area. Protect containers from physical damage. Never store with acids, halogenated hydrocarbons, or strong alkalis.

Engineering Controls: Avoid breathing dust or fumes. Use good housekeeping and cleaning techniques to minimize airborne particulates and to prevent dust accumulation. Provide suitable training in personal hygiene and in the cause and effect of metal fume fever. Prevent exposure of workers with respiratory problems or gastrointestinal disorders.

Transportation Data (49 CFR 172.102)

IMO Shipping Name: Zinc, powder or dust, nonpyrophoric

IMO Hazard Class: 4.3

IMO Label: Dangerous when wet

IMDG Packaging Group: II

IMO Shipping Name: Zinc, powder or dust, pyrophoric

IMO Hazard Class: 4.2

IMO Label: Spontaneously combustible

IMDG Packaging Group: II

MSDS Collection References: 2, 4-11, 24, 31, 39-41, 80, 81, 84, 85, 91, 109

Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** Warren Silverman, MD

ATTACHMENT 2
ACTIVITY HAZARD ANALYSES

ACTIVITY HAZARD ANALYSIS (AHA) 1

Environmental Resources Survey

Metal Debris Reef and Metal Slag Areas

Created by: Lisa Tolbert

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
The purpose of this activity is to document existing environmental conditions and ensure no impacts to sensitive species or their habitat during site characterization activities.		
1. Drive vehicle to site.	Vehicle could hit someone or something.	Follow traffic rules and regulations within and around project site. Wear seatbelts in all vehicles at all times. Drive defensively and be aware of police and fire emergency vehicles around shipyard.
2. Unload equipment and materials, if needed.	Lifting of equipment or materials from vehicle could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift.
3. Observe potential habitat areas.	Slip, trip, and fall hazards could be present.	Visually inspect work areas and mark, barricade, or eliminate slip, trip, and fall hazards. Only walk on surfaces that have the strength and integrity to support employees safely. Avoid walking on riprap or other uneven surfaces, if possible. Some areas have metal marker stakes placed by a previous contractor. These stakes should be tagged or marked with spray paint so that workers avoid them. If possible the stakes should be removed (if acceptable to client) or capped with protectors.
	Worker could be struck by vehicles.	Wear high-visibility reflective vests at all times in work areas. Make eye contact with operators of vehicles. Use traffic controls or barricades, if necessary, to keep traffic away from workers.
4. Delineate potential habitat areas with markers or barricades, if needed.	Handling of barricades could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift. Carry barricades to side of body and ensure that all tips are pointed toward the ground.

Notes:

CIH – Certified Industrial Hygienist

ACTIVITY HAZARD ANALYSIS (AHA) 2

Landside Topographic and Geophysical Surveys Metal Debris Reef and Metal Slag Areas

Created by: Lisa Tolbert

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
The purpose of this activity is to gather elevation and geophysical data for the study areas. This data will be used to develop elevation contour maps of the upland areas and cultural feature maps that will detail the locations of potential interferences, such as structures, fences, and utilities.		
1. Drive survey vehicle to site.	Vehicle could hit someone or something.	Follow traffic rules and regulations within and around project site. Wear seatbelts in all vehicles at all times. Drive defensively and be aware of police and fire emergency vehicles around shipyard.
2. Unload equipment from vehicle.	Lifting of instruments from vehicle could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift.
3. Move equipment to designated survey location.	Handling of instruments could cause strain to worker.	Carry instruments as required by the manufacturer of the instrument. Use straps when provided and adjust for comfort. Use care when walking so that there are no sudden jerks or mis-steps that can cause the worker to strain to maintain control of the instrument. Get assistance from other workers if several instruments must be carried. For loads greater than 50 pounds, use two people to carry.
	Slip, trip, and fall hazards could be present.	Visually inspect work areas and mark, barricade, or eliminate slip, trip, and fall hazards. Only walk on surfaces that have the strength and integrity to support employees safely. Avoid walking on riprap or other uneven surfaces, if possible. Some areas have metal marker stakes placed by a previous contractor. These stakes should be tagged or marked with spray paint so that workers avoid them. If possible the stakes should be removed (if acceptable to client) or capped with protectors.
4. Survey and mark subsurface features, as necessary.	Worker could be struck by vehicles.	Wear high-visibility reflective vests at all times in work areas. Make eye contact with operators of vehicles. Post an observer, as needed, when surveyor is using instruments (a surveyor is often focused on the task and may not be aware of nearby traffic). Use traffic controls or barricades, if necessary, to keep traffic away from workers.
	Use of spray paint to mark underground utilities and anomalies could expose worker to paint or fumes.	Follow manufacturers' instructions on use of paint. Review MSDSs. Never point spray paint canisters at another person.
	Mismarking utilities could create unknown hazards.	Use following universal color codes for utilities: Blue – Water; Red – Electrical; Yellow – Gas; Green – Sewer.
	When carrying stakes, worker could trip and impale body.	Carry stakes in leather or canvas bag that is puncture-proof, and carry bag to side of body. Ensure that all tips are pointed toward ground at all times.
	Installation of wooden stakes presents puncture and splinter hazards.	Keep stake tip pointed at ground. Wear leather gloves. Use caution when using tools to pound stake in.

Notes:

CIH – Certified Industrial Hygienist
MSDS – Material Safety Data Sheets

ACTIVITY HAZARD ANALYSIS (AHA) 3

Marine Bathymetric and Geophysical Surveys

Metal Debris Reef and Metal Slag Areas

Created by: Lisa Tolbert

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
The purpose of this activity is to gather bathymetric and geophysical data for the study areas. This data will be used to develop elevation contour maps of the offshore areas and to correlate the geophysical results with the site bathymetry to select representative locations for placement of borings.		
1. Drive vehicle to site.	Vehicle could hit someone or something.	Follow traffic rules and regulations within and around project site. Wear seatbelts in all vehicles at all times. Drive defensively and be aware of police and fire emergency vehicles around shipyard.
2. Unload vessel and equipment from vehicle and set up base station.	Lifting of equipment from vehicle could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift.
3. Assemble vessel.	Worker could come into contact with electrical hazards during inflation of vessel.	Inspect equipment used to inflate vessel prior to use. Remove any broken or damaged equipment from service. Use tools for intended purposes only and in accordance with manufacturer's instructions.
4. Inspect vessel.	Improper inspection of vessel could cause workers to be exposed to hazards associated with operating vessel and working on water.	Ensure that a competent person inspects vessel and all associated equipment and that vessel is in safe operating condition. Inspect vessel, including emergency equipment, before use and at start of each shift. Verify that vessel is equipped with kill switch, and location of switch is known by all site workers. Operator's manual must be available and reviewed prior to operation.
5. Carry vessel to water and put in water.	Workers could be struck by vessel.	When carrying vessel, clear area of all non-essential personnel.
	Lifting of vessel could cause strain to worker.	Ensure two or more personnel are used to carry vessel to water. Do not place any equipment in the vessel until the vessel is in the water. Use proper lifting techniques such as keeping the back straight, lifting with legs, and limiting twisting.
	Slip, trip, and fall hazards could be present.	Visually inspect path and mark, barricade, or eliminate slip, trip, and fall hazards. Only walk on surfaces that have the strength and integrity to support employees safely. Avoid walking on uneven or slippery surfaces.
6. Move equipment onto vessel.	Handling of instruments could cause strain to worker.	Carry instruments as required by the manufacturer of the instrument. Use straps when provided and adjust for comfort. Use care when walking so that there are no sudden jerks or missteps that can cause the worker to strain to maintain control of the instrument. Get assistance from other workers if several instruments must be carried. For loads greater than 50 pounds, use two people to carry.
	Slip, trip, and fall hazards could be present.	Visually inspect work areas and mark, barricade, or eliminate slip, trip, and fall hazards. Only walk on surfaces that have the strength and integrity to support employees safely. Avoid walking on uneven or slippery surfaces.

ACTIVITY HAZARD ANALYSIS (AHA) 3

Marine Bathymetric and Geophysical Surveys

Metal Debris Reef and Metal Slag Areas

Created by: Lisa Tolbert

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
	Worker could fall off of dock or vessel into water.	Wear USCG-approved Type I, III or V life preservers when on water. Life rings and ropes meeting USCG requirements will be placed on or near debarkation points for vessels and will also be on each vessel. Securely anchor or dock vessels. Position docked vessels with minimum of two lines. Do not load vessel in adverse weather conditions or dangerous seas. (Approval to work in, on or near water must be made by the Project Superintendent and the SSHS.)
7. Mount multibeam sonar head for bathymetric survey.	Pinch points could be present when lowering sonar.	Use care when setting up equipment. Wear leather gloves and get assistance from other workers if necessary.
8. Start outboard motor and operate vessel to perform survey.	Worker could fall overboard.	Wear USCG-approved Type I, III or V life preservers at all times when on water. Remain seated whenever vessel is moving. Do not operate vessel in adverse weather conditions or dangerous seas.
	Vessel could sink, tip, or get stranded.	Do not exceed maximum weight capacity for vessel. Operate vessel with a minimum of two personnel on board. Do not use vessel without shore support personnel and remain in constant radio contact with shore support personnel. Never pitchpole or broach any waves.
	Vessel could come into contact with other vessels.	Watch for other vessels in area and avoid close calls or collisions. Watch for wake from other vessels. Be familiar with the "Rules of the Road" that regulate movement of boat traffic. Verify that vessel has required USCG-approved lighting and signaling devices.
	Sonar or vessel motor could contact debris or sediment surface.	Do not operate vessel near shoreline. Avoid sediment surface by turning sonar to an angle of 30 degrees. Watch for (know their locations or mark with buoys) objects hidden under water at higher tides (pilings, islands, anchor lines, and so forth). Give wide berth to rocks, ledges and man-made subsurface obstructions. In the event vessel becomes grounded at times of low tide, do not move vessel until enough water returns to refloat it.
	Equipment could be crushed or fall overboard.	Do not place instruments near edge of vessel when not in use or not secured. Secure equipment to vessel or personnel when appropriate. Secure all radios and cell phones. Maintain good housekeeping.
	Slip, trip, and fall hazards could be present.	Visually inspect work areas and mark or eliminate slip, trip, and fall hazards. Only work on surfaces that have the strength and integrity to support employees safely. Maintain work areas and means of access in a safe and orderly fashion. Ensure that loads are properly distributed in vessel.
	Fire could occur.	Carry one 10-pound, ABC, dry chemical fire extinguisher on vessel. Evacuate vessel if fire cannot be contained with one fire extinguisher.

ACTIVITY HAZARD ANALYSIS (AHA) 3

Marine Bathymetric and Geophysical Surveys

Metal Debris Reef and Metal Slag Areas

Created by: Lisa Tolbert

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
9. Tie array of magnetometers behind vessel.	Handling of instruments could cause strain to worker.	Handle instruments as required by the manufacturer of the instrument. Get assistance from other workers if loads greater than 50 pounds must be lifted.
	Pinch points could be present.	Use care when handling equipment. Wear leather gloves and get assistance from other workers if necessary.
	Worker could get foot caught in rope used for towing array.	Mark rope for visibility. Stay clear of rope if possible. Maintain work areas and means of access in a safe and orderly fashion.
10. Tow array of magnetometers behind vessel for geophysical survey.	Array could get snagged in debris.	Perform bathymetric survey prior to geophysical survey and review bathymetric data for areas that should be avoided. Watch for (know their locations or mark with buoys) objects hidden under water at higher tides (pilings, islands, anchor lines, and so forth). Give wide berth to rocks, ledges, and man-made subsurface obstructions.

Notes:

CIH – Certified Industrial Hygienist

SHSS – Site Health and Safety Specialist

USCG – United States Coast Guard

ACTIVITY HAZARD ANALYSIS (AHA) 4

Landside Subsurface Coring

Metal Debris Reef and Metal Slag Areas

Created by: Lisa Tolbert

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
The purpose of this activity is to collect landside borings for visual logging, radiological screening, sample collection for chemistry and physical tests, and downhole geophysical investigating. The borings will be collected from locations within the footprint of each of the two study areas and will be positioned within areas that are determined to have slag and metal present. However, an attempt will be made to avoid material that may not be penetrated by a hollow-stem auger.		
1. Drive drilling vehicle to site.	Vehicle could hit someone or something.	Follow traffic rules and regulations within and around project site. Wear seatbelts in all vehicles at all times. Drive defensively and be aware of police and fire emergency vehicles around shipyard.
2. Unload equipment and materials.	Load could have shifted during transport or be poorly tied down, causing load to be unstable.	If load has shifted or tie-downs are poorly installed, do not stand near truck or load. If necessary, remove each tie-down carefully and position heavy equipment on side where tie-down is being removed to prevent load from falling on that side.
	Lifting of equipment and materials from vehicle could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift.
	Cuts and abrasions could occur while moving equipment and materials.	Use leather gloves when moving objects with sharp contact points.
	Slip, trip, and fall hazards could be present.	Visually inspect work areas and mark, barricade, or eliminate slip, trip, and fall hazards. Only walk on surfaces that have the strength and integrity to support employees safely. Avoid walking on riprap or other uneven surfaces, if possible.
3. Inspect drill rig.	Improper inspection of rig could cause workers to be exposed to hazards associated with operating mechanical devices.	Ensure that a competent person inspects rig and all associated equipment and that rig is in safe operating condition. Inspect equipment, including brakes, tire pressure, cables, and hydraulic and pneumatic hoses, before use and at start of each shift. Tag and remove from service faulty or unsafe equipment. Verify that emergency shutdown system is clearly marked, and location is known by all site workers. Verify that shutdown system works properly when trip wire is pulled or pushed. There must be at least two kill switches on the drill rig. Implement EHS 6-2. Operator's manual must be available and reviewed prior to operation.
4. Screen area around boring for radioactive materials.	Slip, trip, and fall hazards could be present.	Visually inspect work areas and mark, barricade, or eliminate slip, trip, and fall hazards. Only walk on surfaces that have the strength and integrity to support employees safely. Avoid walking on riprap or other uneven surfaces, if possible.

ACTIVITY HAZARD ANALYSIS (AHA) 4

Landside Subsurface Coring

Metal Debris Reef and Metal Slag Areas

Created by: Lisa Tolbert

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
5. If needed, hand-auger initial feet of boring.	Hand-augering, digging, or post-holing could cause injury to lower back.	Bend knees and use proper posture and back support while hand-augering, digging, or post-holing boring location. If hand augering, bend knees and use two people, if necessary, to remove auger from hole. If post-holing, ensure that area is clear before striking ground with pike used to break up ground surface.
	Hand-augering, digging, or post-holing over long periods of time could cause muscle strain.	Maintain steady pace and follow rest periods given on job. Select a position during hand-augering to minimize following stressors: chronic muscle contraction or steady force; extreme or awkward positions; repetitive forceful motions; or excessive gripping, pinching, or pressing. Rotate the task with other workers.
	Slip, trip, and fall hazards could be present due to boreholes.	Protect all open boreholes as any open excavation if left unattended (on this project, all boreholes should be filled before end of day). Watch footing in area. Ensure that all hazards have been marked or removed.
	Worker could be struck by vehicles.	Wear high-visibility reflective vests at all times in work areas. Make eye contact with operators of vehicles. Barricade and mark drilling sites for visibility. If necessary, perform traffic controls in accordance with the Traffic Control Plan.
	Worker could experience strain from use of tools.	Inspect all tools for damage before use. Do not use damaged tools (mark and tag "out of service"). Maintain steady pace and follow rest periods given on job. Select hand tools to minimize following stressors: chronic muscle contraction or steady force; extreme or awkward finger/hand/arm positions; repetitive forceful motions; or excessive gripping, pinching, or pressing with hands and fingers.
	Worker could be exposed to chemical or radiological contaminants.	Avoid spills. Ensure that spill cleanup supplies are available. Wear required PPE and respiratory protection as specified in the SHSP. Remove PPE properly and wash hands. Immediately leave area if radioactive materials are present, until the area has been cleared for entrance by the Site Radiation Safety Officer and the SHSS.
6. Position and set up drill rig and associated equipment.	Failure to review site layout plan could cause exposure to potential hazards such as electrocution, damage to underground utilities, or tipping rig over in unstable soil conditions.	Do not move drill rig into any work area until a site layout plan has been completed and route of travel to any worksite has been assessed for hazards (overhead lines and stability of roads and ground). At the pre-activity safety briefing, discuss the site layout plan and analysis of route of travel, along with AHAs. Do not place rig within 15 feet of any overhead electrical lines. When hand-augering a location, ensure that hand-augered area is equal to outside diameter of auger used to advance boring, if applicable. Use a spotter for positioning as necessary.

ACTIVITY HAZARD ANALYSIS (AHA) 4

Landside Subsurface Coring

Metal Debris Reef and Metal Slag Areas

Created by: Lisa Tolbert

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
	Rig could contact overhead lines if transported with mast raised, causing electric shock.	Never move rig when mast is extended.
	Worker could become pinned between rig and other truck components, or worker could be pinned under rig if rig is serviced from under the truck.	When any part of rig or equipment is in motion, stand far enough away from moving parts to avoid being pinned between moving parts. Do not work under rig or truck while rig is supported by lifting jacks. If work must be done under rig or truck, the drill crew supervisor must contact the SHSS to ascertain a safe method for lockout of equipment to ensure that adequate blocking is installed.
	High winds could destabilize rig. Mast could act as a conductor during a thunderstorm.	Check weather conditions and forecasts to determine if conditions are acceptable for use of rig. Do not operate rig if winds exceed manufacturer's recommended tolerances.
	Worker could be exposed to noise.	Wear earplugs whenever drill rig is in operation, if necessary.
	Worker could be exposed to pinch points.	Avoid placing hands close to moving machinery. Wear leather gloves, as appropriate. (Do not wear gloves when near moving parts as gloves or clothing may become entangled in the moving part.) Do not wear loose clothing around any drill rig.
	Electrocutions, explosions, and so forth could occur.	Obtain and examine copies of all pertinent drawings prior to performing this task. Locate and mark existing underground utilities using universal marking codes. Obtain Underground Service Alert clearance (800-642-2444) prior to work. Inspect the area of drilling activity for overhead obstructions. Contact service facility engineer before working near utilities. Ensure that weight of rig is evenly distributed on ground and is not so heavy as to damage any underground lines that may be near the surface (shallow buried PVC lines).
7. Start up rig and advance borehole via augering.	Pressurized hydraulic lines could rupture, causing release of hot hydraulic fluid. Hot fluid could ignite if contact is made with engine, burn workers, and cause environmental contamination.	Ensure that personnel are trained in use of drilling equipment. Inspect all hydraulic lines before placing rig in service. Any damaged hoses or connections must be replaced before unit is used. Immediately shut down equipment if lines rupture. Ensure that first aid kit is readily available to treat injured workers. Ensure that a 20-pound dry chemical ABC fire extinguisher is readily available. Ensure that a spill control kit is available at the drilling location. If rupture occurs, as quickly as possible, berm the liquid to minimize the area over which the liquid spreads. Ensure that all pressurized lines have whip checks.

ACTIVITY HAZARD ANALYSIS (AHA) 4

Landside Subsurface Coring

Metal Debris Reef and Metal Slag Areas

Created by: Lisa Tolbert

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
	Air hoses or hydraulic hoses under pressure could suddenly release, whip, and hit workers causing severe injury.	Do not disconnect air hoses and compressors until hose line has been bled. Visually inspect all connections of any lines under pressure. Use safety clamps (whip checks) to connect each side of connection to other if connection breaks (safety clamps will keep hoses from whipping under sudden release of pressure). Tie back or attach hoses wherever possible to minimize length of hose that could whip around if there is sudden release of pressure.
	Worker could be exposed to chemical or radiological agents.	Verify selection of PPE. Review all MSDSs. If radiological materials are encountered, STOP WORK, and leave area. Do not return to area until authorized by Site Radiological Safety Officer and the SHSS. Decontaminate drilling implements after use (or cover contaminated parts when moving to the next drilling site). Avoid exposure to dust. Use dust control as necessary and possible. Drum and label all soil cuttings. Determine if PPE is contaminated (based on exposure to contaminants) and place contaminated PPE in a separate, properly labeled, container. Discard other PPE as approved by the Metal Reef/Slag PjM and PESM.
	Workers could place hands into moving parts of rig, or loose clothing could become entangled in moving machine parts, either of which could injure worker.	Guard all chains, sprockets, and moving parts. Do not wear loose clothing or any jewelry. Ensure that operator verbally alerts all workers and visually verifies that all workers are clear of dangerous parts of equipment before starting or engaging equipment.
	Worker could be exposed to noise.	Wear earplugs whenever drill rig is in operation, if necessary.
	Worker could be exposed to pinch points.	Avoid placing hands close to moving machinery. Wear gloves, as appropriate. Keep constantly alert.
8. Extract boring and move to sampling location.	Lifting of borings could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift.
	Borings could make contact with someone or something while being carried and are prone to slip.	Wear gloves, as appropriate. Be aware of people or objects that may be vertically or horizontally within length of boring.
9. Decontaminate all reusable materials and equipment.	Lifting of equipment and materials could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift.

ACTIVITY HAZARD ANALYSIS (AHA) 4

Landside Subsurface Coring

Metal Debris Reef and Metal Slag Areas

Created by: Lisa Tolbert

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
	Worker could be exposed to chemical or radiological contaminants.	Avoid spills. Ensure that spill cleanup supplies are available. Wear required PPE and respiratory protection as specified in the SHSP. Visual inspection will determine selection of PPE and respiratory protection. Remove PPE properly and wash hands.
	Decontamination area may become slippery.	Visually inspect work areas and mark, barricade, or eliminate slip, trip, and fall hazards as feasible. Maintain proper illumination in all work areas. If decontaminating on plastic sheeting, use caution since plastic sheeting is extremely slippery. Wear boots with good traction.

Notes:

AHA – Activity Hazard Analysis

CIH – Certified Industrial Hygienist

EHS – Environmental Health and Safety

MSDS – Material Safety Data Sheet

PESM – Project Environmental and Safety Manager

PjM – Project Manager

PPE – personal protective equipment

PVC – polyvinyl chloride

SHSP – Site-Specific Health and Safety Plan

SHSS – Site Health and Safety Supervisor

ACTIVITY HAZARD ANALYSIS (AHA) 5

Marine Subsurface Coring

Metal Debris Reef and Metal Slag Areas

Created by: Lisa Tolbert

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
<p>The purpose of this activity is to collect marine (offshore) borings for visual logging, radiological screening, and sample collection for chemistry and physical tests. The borings will be collected from locations around the perimeter of each of the two study areas with either a hollow-stem auger or a vibracore system, depending on site conditions. Since it is not yet known how far into the bay the metal debris reef and metal slag areas extend, a barge may be needed for drilling offshore with the hollow-stem auger. If a barge is required, the vibracoring may be eliminated, and all borings will be collected with a hollow-stem auger.</p> <p>In addition, surface water samples will be collected during boring activities for use as supply water for column settling and elutriate tests and for chemical analysis.</p>		
1. Drive vehicle to site or submarine bay.	Vehicle could hit someone or something.	Follow traffic rules and regulations within and around shipyard. Wear seatbelts in all vehicles at all times. Drive defensively and be aware of police and fire emergency vehicles around shipyard.
2. Unload equipment and materials from vehicle.	Load could have shifted during transport or be poorly tied down, causing load to be unstable.	If load has shifted or tie-downs are poorly installed, do not stand near truck or load. If necessary, remove each tie-down carefully and position heavy equipment on side where tie-down is being removed to prevent load from falling on that side.
	Lifting of equipment and materials from vehicle could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift.
	Cuts and abrasions could occur while moving equipment and materials.	Use leather gloves when moving objects with sharp contact points.
	Slip, trip, and fall hazards could be present.	Visually inspect work areas and mark, barricade, or eliminate slip, trip, and fall hazards. Only work on walking/working surfaces that have the strength and integrity to support employees safely. Openings 18 inches or more in diameter must be covered and marked. All openings less than 18 inches in diameter and all holes must be marked or barricaded. Avoid walking on uneven or slippery surfaces.
3. If using Zodiaks, assemble vessels.	Worker could come into contact with electrical hazards during inflation of vessel.	Inspect equipment used to inflate vessel prior to use. Remove any broken or damaged equipment from service. Use tools for intended purposes only and in accordance with manufacturer's instructions.
4. Inspect vessels.	Improper inspection of vessel could cause workers to be exposed to hazards associated with operating vessel and working on water.	Ensure that a competent person inspects vessel and all associated equipment and that vessel is in safe operating condition. Inspect vessel, including emergency equipment and life preservers, before use and at start of each shift. Verify that vessel is equipped with kill switch, and location of switch is known by all site workers. Operator's manual must be available and reviewed prior to operation.

ACTIVITY HAZARD ANALYSIS (AHA) 5

Marine Subsurface Coring

Metal Debris Reef and Metal Slag Areas

Created by: Lisa Tolbert

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
5. Carry vessels to water and put in water.	Workers could be struck by vessel.	When carrying vessel, clear area of all non-essential personnel.
	Lifting of vessel could cause strain to worker.	Ensure that two or more personnel are used to carry vessel to water. Do not place any equipment in the vessel until the vessel is in the water. Use proper lifting techniques such as keeping the back straight, lifting with legs, and limiting twisting.
	Slip, trip, and fall hazards could be present.	Visually inspect path and mark, barricade, or eliminate slip, trip, and fall hazards. Only walk on surfaces that have the strength and integrity to support employees safely. Avoid walking on uneven or slippery surfaces.
6. Move equipment onto vessels and set up vibracore.	Handling of instruments could cause strain to worker.	Carry instruments as required by the manufacturer of the instrument. Use straps when provided and adjust for comfort. Use care when walking so that there are no sudden jerks or mis-steps that can cause the worker to strain to maintain control of the instrument. Get assistance from other workers if several instruments must be carried. For loads greater than 50 pounds, use two people to carry.
	Slip, trip, and fall hazards could be present.	Visually inspect work areas and mark, barricade, or eliminate slip, trip, and fall hazards. Only walk on surfaces that have the strength and integrity to support employees safely. Avoid walking on uneven or slippery surfaces.
	Worker could fall off of dock or vessel into water.	Wear USCG-approved Type I, III or V life preservers when on water. Securely anchor or dock vessels. Position docked vessels with minimum of two lines. Do not load vessel in adverse weather conditions or dangerous seas.
7. Start outboard motor and operate vessel to travel to sample location.	Worker could fall overboard.	Wear USCG-approved Type I, III or V life preservers at all times when on water. Remain seated whenever vessel is moving. Do not operate vessel in adverse weather conditions or dangerous seas.
	Vessel could sink, tip, or get stranded.	Do not exceed maximum weight capacity for vessel. Operate vessel with a minimum of two personnel on board. Do not use vessel without shore support personnel and remain in constant radio contact with shore support personnel. Never pitchpole or broach any waves.
	Vessel could come into contact with other vessels.	Watch for other vessels in area and avoid close calls or collisions. Watch for wake from other vessels. Be familiar with the "Rules of the Road" that regulate movement of boat traffic. Verify that vessel has required USCG-approved lighting and signaling devices.
	Sonar or vessel motor could contact debris or sediment surface.	Do not operate vessel near shoreline. Avoid sediment surface by turning sonar to an angle of 30 degrees. Watch for (know their locations or mark with buoys) objects hidden under water at higher tides (pilings, islands, anchor lines, and so forth). Give wide berth to rocks, ledges and man-made subsurface obstructions. In the event the vessel becomes grounded at times of low tide, do not move vessel until enough water returns to refloat it.

ACTIVITY HAZARD ANALYSIS (AHA) 5

Marine Subsurface Coring

Metal Debris Reef and Metal Slag Areas

Created by: Lisa Tolbert

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
	Equipment could be crushed or fall overboard.	Do not place instruments near edge of vessel when not in use or not secured. Secure equipment to vessel or personnel when appropriate. Secure all radios and cell phones. Maintain good housekeeping.
	Slip, trip, and fall hazards could be present.	Visually inspect work areas and mark or eliminate slip, trip, and fall hazards. Only work on surfaces that have the strength and integrity to support employees safely. Maintain work areas and means of access in a safe and orderly fashion. Ensure that loads are properly distributed in vessel.
	Fire could occur.	Carry one 10-pound, ABC, dry chemical fire extinguisher on vessel. Evacuate vessel if fire cannot be contained with one fire extinguisher.
8. If using barge, inspect vessel.	Improper inspection of vessel could cause workers to be exposed to hazards associated with operating vessel and working on water.	Ensure that a competent person inspects vessel and all associated equipment and that vessel is in safe operating condition. Inspect vessel, including navigation lights, fuel supply hose, life preservers, hull, and so forth, before use and at start of each shift. Verify that inspection checklist has been completed. Verify that vessel is equipped with kill switch, and location of switch is known by all site workers. Operator's manual must be available and reviewed prior to operation.
9. Move equipment onto vessel and board vessel.	Handling of instruments could cause strain to worker.	Carry instruments as required by the manufacturer of the instrument. Use straps when provided and adjust for comfort. Use care when walking so that there are no sudden jerks or mis-steps that can cause the worker to strain to maintain control of the instrument. Get assistance from other workers if several instruments must be carried. For loads greater than 50 pounds, use two people to carry.
	Slip, trip, and fall hazards could be present.	Visually inspect work areas and mark, barricade, or eliminate slip, trip, and fall hazards. Only walk on surfaces that have the strength and integrity to support employees safely. Avoid walking on uneven or slippery surfaces.
	Worker could fall off of dock or vessel into water.	Wear USCG-approved Type I, III or V life preservers when near water. Securely anchor or dock vessels. Position docked vessels with minimum of two lines. Do not load vessel in adverse weather conditions or dangerous seas.
10. Operate vessel to travel to location of hollow-stem auger.	Worker could fall overboard.	Wear USCG-approved Type I, III or V life preservers at all times when on water. Remain seated whenever vessel is moving. Do not operate vessel in adverse weather conditions or dangerous seas.
	Vessel could sink, tip, or get stranded.	Do not exceed maximum weight capacity for vessel. Operate vessel with a minimum of two personnel on board. Do not use vessel without shore support personnel and remain in constant radio contact with shore support personnel. Never pitchpole or broach any waves.

ACTIVITY HAZARD ANALYSIS (AHA) 5

Marine Subsurface Coring

Metal Debris Reef and Metal Slag Areas

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Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
	Vessel could come into contact with other vessels.	Watch for other vessels in area and avoid close calls or collisions. Watch for wake from other vessels. Be familiar with the "Rules of the Road" that regulate movement of boat traffic. Verify that vessel has required USCG-approved lighting and signaling devices.
	Equipment could be crushed or fall overboard.	Do not place instruments near edge of vessel when not in use or not secured. Secure equipment to vessel or personnel when appropriate. Secure all radios and cell phones. Maintain good housekeeping.
	Slip, trip, and fall hazards could be present.	Visually inspect work areas and mark, barricade, or eliminate slip, trip, and fall hazards. Only work on walking/working surfaces that have the strength and integrity to support employees safely. Wear high-traction boots. Use non-slip surfaces for work area. Maintain work areas and means of access safe and orderly. Close all open deck hatches. Ensure that decks and stairways have guardrails. Ensure that loads are properly distributed in vessel. Do not allow oil and grease to build up on walking surfaces.
	Fire could occur.	Carry one 10-pound, ABC, dry chemical fire extinguisher on vessel. Evacuate vessel if fire cannot be contained with one fire extinguisher.
11. Dock vessel.	Vessel could hit dock. Personnel could fall off dock or barge as lines are thrown and barge is tied off to dock.	Operator of vessel must have experience and training as required by the USGS. Personnel on vessel and on dock must be trained and competent in procedures to dock vessel. All other personnel must stand away from the edge of the barge and non-trained personnel should not be on the dock. Personnel working on edge of barge and on the dock must wear personal flotation devices.
12. Inspect auger.	Improper inspection of rig could cause workers to be exposed to hazards associated with operating mechanical devices.	Ensure that rig and all associated equipment are inspected by a competent person and that rig is in safe operating condition. Inspect equipment, including cables and hydraulic and pneumatic hoses, before use and at start of each shift. Tag and remove from service faulty or unsafe equipment. Verify that emergency shutdown system is clearly marked, and location is known by all site workers. Verify that shutdown system works properly when trip wire is pulled or pushed. Implement EHS 6-2. Operator's manual must be available and reviewed prior to operation.
13. Load auger onto barge.	Hazards associated with crane use may arise should cranes be used.	Should cranes be used, an AHA will be developed.
14. Operate vessel to travel to sample location.	Boating hazards associated with weather, other vessels in area, water hazards could be present.	Do not operate vessel, or work in or near water until clearance is received from Project Superintendent and the SHSS. Ensure that inspections have been conducted. Follow USCG rules for operation of vessels near other vessels.

ACTIVITY HAZARD ANALYSIS (AHA) 5

Marine Subsurface Coring

Metal Debris Reef and Metal Slag Areas

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Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
15. For vibracoring or hollow-stem augering, position vessel and set up drill rig and associated equipment.	Failure to review site layout plan could cause exposure to potential hazards such as electrocution, damage to underground utilities, or collision with underwater obstacles.	Do not move drill rig into any work area until a site layout plan has been completed and route of travel to any worksite has been assessed for hazards (overhead lines and underwater obstacles). At the pre-activity safety briefing, discuss the site layout plan and analysis of route of travel, along with AHAs. Do not place vessel within 15 feet of any overhead electrical lines. Use a spotter for positioning as necessary.
	Lifting system may not have sufficient rating for weight be lifted, or it may be defective. Coring cable could break under strain.	Inspect A-frame winch and cable. Inspect cable prior to work each day and constantly watch for kinks, strand breaks and general condition. Verify the weight rating on the cable. All personnel will stand clear of the cable during operations and will ensure that they are wearing hard hats, safety glasses, a safety vest, and eye and foot protection. The ESS will ensure that personnel comply with this requirement.
	Vessel could contact overhead lines if transported with mast raised, causing electric shock.	Never move vessel when mast is extended.
	Worker could become pinned between equipment and other vessel components.	When any part of equipment is in motion, stand far enough away from moving parts to avoid being pinned between moving parts. If work must be done under rig, the drill crew supervisor must contact the SHSS to ascertain a safe method for lockout of equipment to ensure that adequate blocking is installed.
	High winds could destabilize rig. Mast could act as a conductor during a thunderstorm.	Check weather conditions and forecasts to determine if conditions are acceptable for use of rig. Do not operate rig if winds exceed manufacturer's recommended tolerances.
	Worker could be exposed to noise.	Wear earplugs whenever drill rig is in operation, if necessary.
	Worker could be exposed to pinch points.	Avoid placing hands close to moving machinery. Wear leather gloves, as appropriate. (Do not wear gloves when near moving parts as gloves or clothing may become entangled in the moving part.)
	Electrocutions, explosions, and so forth could occur.	Obtain and examine copies of all pertinent drawings prior to performing this task. Locate and mark existing underground utilities using universal marking codes. Obtain Underground Service Alert clearance (800-642-2444) prior to work. Inspect the area of drilling activity for overhead obstructions. Contact service facility engineer before working near utilities. Ensure that weight on vessel is evenly distributed to avoid tipping or damaging equipment.

ACTIVITY HAZARD ANALYSIS (AHA) 5

Marine Subsurface Coring

Metal Debris Reef and Metal Slag Areas

Created by: Lisa Tolbert

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
16. Start up vibracore or hollow-stem auger and perform drilling.	Pressurized hydraulic lines could rupture, causing release of hot hydraulic fluid. Hot fluid could ignite if contact is made with engine, burn workers, and cause environmental contamination.	Ensure that personnel are trained in use of drilling equipment. Inspect all hydraulic lines before placing rig in service. Any damaged hoses or connections must be replaced before unit is used. Immediately shut down equipment if lines rupture. Ensure that first aid kit is readily available to treat injured workers. Ensure that a 20-pound, ABC, dry chemical fire extinguisher and spill control kit are readily available. If rupture occurs, as quickly as possible, berm the liquid to minimize the area over which the liquid spreads. Ensure that all pressurized lines have whip checks.
	Air hoses or hydraulic hoses under pressure could suddenly release, whip, and hit workers causing severe injury.	Do not disconnect air hoses and compressors until hose line has been bled. Visually inspect all connections of any lines under pressure. Use safety clamps (whip checks) to connect each side of connection to other if connection breaks (safety clamps will keep hoses from whipping under sudden release of pressure). Tie back or attach hoses wherever possible to minimize length of hose that could whip around if there is sudden release of pressure.
	Worker could be exposed to chemical or radiological agents.	Verify selection of PPE with ambient air/visual monitoring. Review all MSDSs. Decontaminate drilling implements after use (or cover contaminated parts when moving to the next drilling site). Drum and label all soil cuttings. Determine if PPE is contaminated (based on exposure to contaminants) and place contaminated PPE in a separate, properly labeled, container. Discard other PPE as approved by the Metal Reef/Slag PjM and PESM.
	Workers could place hands into moving parts of rig, or loose clothing could become entangled in moving machine parts, either of which could injure worker.	Guard all chains, sprockets, and moving parts. Do not wear loose clothing or any jewelry. Ensure that operator verbally alerts all workers and visually verifies that all workers are clear of dangerous parts of equipment before starting or engaging equipment.
	Worker could be exposed to noise.	Wear earplugs whenever drill rig is in operation, if necessary.
	Worker could be exposed to pinch points.	Avoid placing hands close to moving machinery. Wear gloves, as appropriate. Keep constantly alert.
	Slip, trip, and fall hazards could be present.	Visually inspect work areas and mark, barricade, or eliminate slip, trip, and fall hazards. Only work on walking/working surfaces that have the strength and integrity to support employees safely. Wear high-traction boots. Use non-slip surfaces for work area. Maintain work areas and means of access in a safe and orderly fashion. Close all open deck hatches. Ensure that decks and stairways have guardrails. Ensure that loads are properly distributed in vessel. Do not allow oil and grease to build up on walking surfaces.

ACTIVITY HAZARD ANALYSIS (AHA) 5

Marine Subsurface Coring

Metal Debris Reef and Metal Slag Areas

Created by: Lisa Tolbert

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
17. Set aside boring for transport to sampling location.	Lifting of borings could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift.
	Borings could make contact with someone or something while being carried and are prone to slip.	Wear gloves, as appropriate. Be aware of people or objects that may be vertically or horizontally within length of boring.
18. Collect surface water sample.	Worker or peristaltic pump could fall overboard.	Wear USCG-approved Type I, III or V life preservers at all times when on water. Only collect water samples when vessel is stationary. Place peristaltic pump far enough away from the edge of the vessel so that it is not knocked overboard.
	Worker could be exposed to chemical or radiological contaminants.	Avoid spills. Ensure that spill cleanup supplies are available. Wear required PPE and respiratory protection as specified in the SHSP. Visual inspection and ambient air monitoring will determine selection of PPE and respiratory protection. Remove PPE properly and wash hands.
19. Pack samples for shipment.	Manually moving materials and equipment could cause strains.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck when handling more than one box at a time. Try to pack shipping boxes so that each box does not exceed 50 pounds. For loads greater than 50 pounds, use two people to carry.
	Contents of sample containers could leak, causing exposure to worker and possibly to people handling shipping box.	Ensure that each container top is securely tightened. Pack each container in a manner to prevent damage to container during handling of shipping box and during transportation. Ensure that boxes meet required packaging standards based on mode of transportation used for shipping.
20. Decontaminate all reusable materials and equipment.	Lifting of equipment and materials could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift.
	Worker could be exposed to chemical or radiological contaminants.	Avoid spills. Ensure that spill cleanup supplies are available. Wear required PPE and respiratory protection as specified in the SHSP. Visual inspection and ambient air monitoring will determine selection of PPE and respiratory protection. Remove PPE properly and wash hands.
	Decontamination area may become slippery.	Visually inspect work areas and mark, barricade, or eliminate slip, trip, and fall hazards as feasible. Maintain proper illumination in all work areas. If decontaminating on plastic sheeting, use caution since plastic sheeting is extremely slippery. Wear boots with good traction.

Notes:

AHA – Activity Hazard Analysis
MSDS – Material Safety Data Sheet
PESM – Project Environmental and Safety Manager
PjM – Project Manager
PPE – personal protective equipment
PVC – polyvinyl chloride
SHSP – Site-Specific Health and Safety Plan
SHSS – Site Health and Safety Supervisor
USCG – United States Coast Guard

ACTIVITY HAZARD ANALYSIS (AHA) 6

Subsurface Characterization

Metal Debris Reef and Metal Slag Areas

Created by: Lisa Tolbert

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
<p>The purpose of this activity is to collect soil and sediment samples for chemistry and physical tests and perform downhole geophysical investigations. For chemical testing of the landside borings, a sediment sample will be collected from each boring at the following three depths: 1) a depth corresponding to approximately 1/2 the total thickness of the metal debris, 2) immediately below the metal debris, and 3) the bottom of each approximately 10-foot-deep boring. For chemical testing of the perimeter borings, a sediment sample will be collected from each boring at the following three depths: 1) the surface, 2) the same elevation as the bottom of the adjacent metal debris, 3) the bottom of each approximate 10-foot-deep boring. For geotechnical testing, sediment from the first sample depth (a sample from a depth corresponding to approximately 1/2 the total thickness of the metal debris) that is left over after collection of the sediment sample for chemical analysis will be used for geotechnical testing.</p> <p>Immediately after sample acquisition, the sample core will be screened for potential radiological contamination. If radiological contamination is present, the sample core will be containerized, and samples will not be collected from the core.</p>		
1. Move boring to sampling location.	Lifting of borings could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift.
	Borings could make contact with someone or something while being carried and are prone to slip.	Wear gloves, as appropriate. Be aware of people or objects that may be vertically or horizontally within length of boring.
2. Remove fittings and open sampler.	Cutting implement could injure worker's hands.	Wear nitrile or leather gloves while opening sampler. If using a knife or saw, cut away from your body. Watch placement of hands to make sure that they are away from path of cutting implement. Ensure that sample tube is stable before cutting.
	Worker could experience strain from use of tools.	Inspect all tools for damage before use. Do not use damaged tools (mark and tag "out of service"). Maintain steady pace and follow rest periods given on job. Select hand tools to minimize following stressors: chronic muscle contraction or steady force; extreme or awkward finger/hand/arm positions; repetitive forceful motions; or excessive gripping, pinching, or pressing with hands and fingers.
	Worker could be exposed to chemical or radiological contaminants.	Avoid spills. Ensure that spill cleanup supplies are available. Wear required PPE and respiratory protection as specified in the SHSP. Visual inspection and ambient air monitoring will determine selection of PPE and respiratory protection. Remove PPE properly and wash hands.
3. Screen core for radiological contamination.	Worker could be exposed to chemical or radiological contaminants.	Avoid spills. Ensure that spill cleanup supplies are available. Wear required PPE and respiratory protection as specified in the SHSP. Visual inspection and ambient air monitoring will determine selection of PPE and respiratory protection. Remove PPE properly and wash hands.

ACTIVITY HAZARD ANALYSIS (AHA) 6

Subsurface Characterization

Metal Debris Reef and Metal Slag Areas

Created by: Lisa Tolbert

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
4. If radiological contamination is detected, dispose of core.	Lifting of materials could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift.
	Worker could be exposed to chemical or radiological contaminants.	Avoid spills. Ensure that spill cleanup supplies are available. Wear required PPE and respiratory protection as specified in the SHSP. Visual inspection and ambient air monitoring will determine selection of PPE and respiratory protection. Remove PPE properly and wash hands.
5. Collect samples from core.	Worker could experience strain from use of tools.	Inspect all tools for damage before use. Do not use damaged tools (mark and tag "out of service"). Maintain steady pace and follow rest periods given on job. Select hand tools to minimize following stressors: chronic muscle contraction or steady force; extreme or awkward finger/hand/arm positions; repetitive forceful motions; or excessive gripping, pinching, or pressing with hands and fingers.
	Worker could be exposed to chemical or radiological contaminants.	Avoid spills. Ensure that spill cleanup supplies are available. Wear required PPE and respiratory protection as specified in the SHSP. Visual inspection and ambient air monitoring will determine selection of PPE and respiratory protection. Remove PPE properly and wash hands.
	Lifting of sampler could cause injury to lower back.	Bend knees and use proper posture and back support while collecting sample. Use two people, if necessary, to extract sampler from soil.
	Slip, trip, and fall hazards could be present due to boreholes.	Protect all open boreholes as any open excavation if left unattended (on this project, all boreholes should be filled before end of day).
6. Perform downhole geophysical investigation.	Lifting of probe could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift.
	Slip, trip, and fall hazards could be present due to work area and open boreholes.	Visually inspect work areas and mark, barricade, or eliminate slip, trip, and fall hazards. Only walk on surfaces that have the strength and integrity to support employees safely. Avoid walking on riprap or other uneven surfaces, if possible. Protect all open boreholes as any open excavation if left unattended (on this project, all boreholes should be filled before end of day).
7. Decontaminate all reusable materials and equipment.	Lifting of equipment and materials could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift.

ACTIVITY HAZARD ANALYSIS (AHA) 6

Subsurface Characterization

Metal Debris Reef and Metal Slag Areas

Created by: Lisa Tolbert

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
	Worker could be exposed to chemical or radiological contaminants.	Avoid spills. Ensure that spill cleanup supplies are available. Wear required PPE and respiratory protection as specified in the SHSP. Visual inspection and ambient air monitoring will determine selection of PPE and respiratory protection. Remove PPE properly and wash hands.
	Decontamination area may become slippery.	Visually inspect work areas and mark, barricade, or eliminate slip, trip, and fall hazards as feasible. Maintain proper illumination in all work areas. If decontaminating on plastic sheeting, use caution since plastic sheeting is extremely slippery. Wear boots with good traction.
8. Pack samples for shipment.	Manually moving materials and equipment could cause strains.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck when handling more than one box at a time. Try to pack shipping boxes so that each box does not exceed 50 pounds. For loads greater than 50 pounds, use two people to carry.
	Contents of sample containers could leak, causing exposure to worker and possibly to people handling shipping box.	Ensure that each container top is securely tightened. Pack each container in a manner to prevent damage to container during handling of shipping box and during transportation. Ensure that boxes meet required packaging standards based on mode of transportation used for shipping.

Notes:

CIH – Certified Industrial Hygienist

PPE – personal protective equipment

SHSP – Site-Specific Health and Safety Plan

ACTIVITY HAZARD ANALYSIS (AHA) 7

Waste Profiling

Metal Debris Reef and Metal Slag Areas

Created by: Lisa Tolbert

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
The purpose of this activity is to characterize, transport, and dispose of wastes generated during site characterization activities. The wastes that will require sampling may include: 1) sediment generated during drilling activities, 2) radiological devices, and 3) wastewater from decontamination. Wastes will be stored in drums on site or other appropriate containers.		
1. Place/pour waste into containers (55-gallon drum, roll-off bin, and so forth).	Lifting of wastes could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. If possible, do not create loads greater than 50 pounds. If loads are greater than 50 pounds, use two people to lift.
	Worker could be exposed to chemical or radiological contaminants.	Wear required PPE. Visual inspection and ambient air monitoring will determine selection of PPE and respiratory protection. Decontaminate exteriors of tools or buckets used to transport wastes to containers. Avoid spills. Ensure that spill cleanup supplies are available.
2. Load drums onto vehicle.	Handling of drums can expose worker to injury (including, but not limited to, strains, lacerations, and pinch points).	Ensure that drums are individually and properly labeled and that labels are visible when drums are placed on truck. Use truck that has "Tommy Lift" and move drum using drum dolly onto lift. Ensure that drum is secure and will not roll when lift is raised. Wheel drum to appropriate location on truck for transport. Be sure to evenly distribute load weight on bed of truck. Secure drums in place on the truck. If drums are loaded with drum handling device attached to backhoe or excavator, stand away from truck when drum is placed on truck. Once drum is in place and "loader" moves away from truck, use drum dolly on truck to position drum. Avoid placing pallets of drums on truck unless pallets can be positioned where they will remain for transport. (It is very difficult to move loaded pallets manually.)
	Worker could be struck by vehicles.	Wear high-visibility reflective vests at all times in work areas. Make eye contact with operators of vehicles. Post an observer, as needed, when loading drums close to busy streets. Use traffic controls or barricades, if necessary, to keep traffic away from workers.
3. Transport drums to temporary storage location.	Drums may leak.	Inspect all drums prior to and following transport. Have spill cleanup supplies and equipment readily available. Surface may become slippery. Wear work boots with good traction soles. Avoid exposure to material. Wear appropriate PPE. Clean up all spills immediately. Notify supervisor.

ACTIVITY HAZARD ANALYSIS (AHA) 7

Waste Profiling

Metal Debris Reef and Metal Slag Areas

Created by: Lisa Tolbert

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
	Handling of drums can expose worker to injury (including, but not limited to, strains, lacerations, and pinch points).	If handling drums, use drum dolly, pallet on forklift, or drum grabber attached to backhoe or excavator to move drums into storage. If handling drums, inspect path that drum must be moved over. Ensure that there are no ruts or other obstacles that can cause drum to tip over or be difficult to handle over surface being traversed. Place drums in approved storage area. When manually handling drums, avoid placing hands between drums and pinching fingers. Wear leather work gloves. If drums have to be manually positioned, know how to "break and roll" drum. Avoid manually positioning drums if at all possible. Only one person should "break and roll" drum if necessary to manually move drum without mechanical assistance.
	Slip, trip, and fall hazards could be present.	Maintain good housekeeping and proper illumination in storage area.
4. Store drums in temporary storage location pending characterization.	Drums may leak.	Inspect all containers on a regular basis (weekly for non-hazardous materials, daily for hazardous materials). Have spill cleanup supplies and equipment readily available. Surface may become slippery. Wear work boots with good traction soles. Avoid exposure to material. Wear appropriate PPE. Clean up all spills immediately. Notify supervisor.
5. Remove cover of containers for sampling.	Lifting drum lids may cause injury, particularly to fingers and hands.	Identify and avoid pinch points, such as placing hands between drum lid and drum. Wear leather work gloves when removing and replacing drum lids.
	Worker could experience strain from use of tools.	Inspect all tools for damage before use. Do not use damaged tools (mark and tag "out of service"). Select hand tools to minimize following stressors: chronic muscle contraction or steady force; extreme or awkward finger/hand/arm positions; repetitive forceful motions; or excessive gripping, pinching, or pressing with hands and fingers.
	Containers could contain atmospheric hazards, thus exposing worker to vapors.	Before fully lifting container covers, place probe through small opening or at top of open bung and measure air inside using a PID or FID. If reading is less than 10 ppm, open cover and proceed with sampling. If reading is greater than 10 ppm, remove cover slowly and stand back to allow cover to ventilate. Measure air inside again after 5 minutes, and if readings are still above 10 ppm, contact the SHSS.
6. Collect sample of waste.	Worker could be exposed to chemical or radiological contaminants.	Wear required PPE. Visual inspection and ambient air monitoring will determine selection of PPE and respiratory protection. Decontaminate exteriors of sample containers. Avoid spills. Ensure that spill cleanup supplies are available.

ACTIVITY HAZARD ANALYSIS (AHA) 7

Waste Profiling

Metal Debris Reef and Metal Slag Areas

Created by: Lisa Tolbert

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
7. Replace container covers.	Replacing drum lids may cause injury, particularly to fingers and hands.	Use care when replacing drum lids. Wear leather gloves when handling lids.
	Worker could experience strain from use of tools.	Inspect all tools for damage before use. Do not use damaged tools. Mark and tag "out of service." Select hand tools to minimize the following stressors: chronic muscle contraction or steady force; extreme or awkward finger/hand/arm positions; repetitive forceful motions; or excessive gripping, pinching, or pressing with hands and fingers.
8. Pack samples for shipment.	Manually moving materials and equipment could cause strains.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck when handling more than one box at a time. Try to pack shipping boxes so that each box does not exceed 50 pounds. For loads greater than 50 pounds, use two people to carry.
	Contents of sample containers could leak, causing exposure to worker and possibly to people handling shipping box.	Ensure that each container top is securely tightened. Pack each container in a manner to prevent damage to container during handling of shipping box and during transportation. Ensure that boxes meet required packaging standards based on mode of transportation used for shipping.
9. Decontaminate all reusable materials and equipment.	Lifting of equipment and materials could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift.
	Worker could be exposed to chemical contaminants.	Avoid spills. Ensure that spill cleanup supplies are available. Wear required PPE and respiratory protection as specified in the SHSP. Visual inspection and ambient air monitoring will determine selection of PPE and respiratory protection. Remove PPE properly and wash hands.
	Decontamination area may become slippery.	Visually inspect work areas and mark, barricade, or eliminate slip, trip, and fall hazards as feasible. Maintain proper illumination in all work areas. If decontaminating on plastic sheeting, use caution since plastic sheeting is extremely slippery. Wear boots with good traction.

ACTIVITY HAZARD ANALYSIS (AHA) 7

Waste Profiling

Metal Debris Reef and Metal Slag Areas

Created by: Lisa Tolbert

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
10. Load containers for transport.	Handling of containers can expose worker to injury (including, but not limited to, strains, lacerations, and pinch points).	Ensure that drums are individually, and properly labeled (new labels as appropriate based on analytical results) and that labels are visible when drums are placed on truck. Use truck that has "Tommy Lift" and move drum using drum dolly onto lift. Ensure that drum is secure and will not roll when lift is raised. Wheel drum to appropriate location on truck for transport. Be sure to evenly distribute load weight on bed of truck. Secure drums in place on the truck. If drums are loaded with drum handling device attached to backhoe or excavator, stand away from truck when drum is placed on truck. Once drum is place and "loader" moves away from truck, use drum dolly on truck to position drum. Avoid placing pallets of drums on truck, unless pallets can be positioned where they will remain for transport. (It is very difficult to move loaded pallets manually.)
	Worker could be struck by vehicles.	Wear high-visibility reflective vests at all times in work areas. Make eye contact with operators of vehicles. Post an observer, as needed, when loading drums close to busy streets. Use traffic controls or barricades, if necessary, to keep traffic away from workers.
	Containers may leak.	Inspect all containers prior to transport. Have spill cleanup supplies and equipment readily available. Surface may become slippery. Wear work boots with good traction soles. Avoid exposure to material. Wear appropriate PPE. Clean up all spills immediately. Notify supervisor.

Notes:

CIH – Certified Industrial Hygienist

FID – flame ionization detector

PID – photoionization detector

PPE – personal protective equipment

ppm – parts per million

SHSP – Site-Specific Health and Safety Plan

SHSS – Site Health and Safety Specialist

ACTIVITY HAZARD ANALYSIS (AHA) 8

Site Restoration

Metal Debris Reef and Metal Slag Areas

Created by: Lisa Tolbert

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
The purpose of this activity is to restore the site, which consists of decommissioning any open boreholes.		
1. Unload equipment and materials.	Load could have shifted during transport or be poorly tied down, causing load to be unstable.	If load has shifted or tie-downs are poorly installed, do not stand near truck or load. If necessary, remove each tie-down carefully and position heavy equipment on side where tie-down is being removed to prevent load from falling on that side.
	Lifting of equipment and materials from vehicle could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift.
	Cuts and abrasions could occur while moving equipment and materials.	Use leather gloves when moving objects with sharp contact points.
	Slip, trip, and fall hazards could be present.	Visually inspect work areas and mark, barricade, or eliminate slip, trip, and fall hazards. Only work on walking/working surfaces that have the strength and integrity to support employees safely. Openings 18 inches or more in diameter must be covered and marked. All openings less than 18 inches in diameter and all holes must be marked or barricaded.
	Worker could be exposed to pinch points.	Avoid placing hands close to moving machinery. Wear gloves, as appropriate. Keep constantly alert.
2. Mix grout.	Lifting of materials could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift.
	Worker could be come into contact with grout.	Avoid spills. Wear designated PPE. Remove PPE properly and wash hands. Avoid generating dust. Review MSDS for grout. If high in silica content, wear dust mask when handling dry grout.
3. Pour grout into borehole to seal.	Lifting of materials could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift.
	Worker could be come into contact with grout.	Avoid spills. Wear designated PPE. Remove PPE properly and wash hands.
	Grout could cause probe rods to be slippery.	Wear gloves, as appropriate. Use extra caution while removing rods and handling them, as they are prone to slip.
4. Finish boring at surface with concrete or asphalt, as necessary.	Worker could be come into contact with concrete or asphalt.	Avoid spills. Wear designated PPE. Remove PPE properly and wash hands.

ACTIVITY HAZARD ANALYSIS (AHA) 8

Site Restoration

Metal Debris Reef and Metal Slag Areas

Created by: Lisa Tolbert

Reviewed by: Roger Margotto, CIH

Job Steps	Possible Hazards	Protection Against Hazards
5. Decontaminate all reusable materials and equipment.	Lifting of equipment and materials could cause strain to worker.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use hand truck if needed. For loads greater than 50 pounds, use two people to lift.
	Worker could be exposed to chemical contaminants.	Avoid spills. Ensure that spill cleanup supplies are available. Wear required PPE and respiratory protection as specified in the SHSP. Visual inspection and ambient air monitoring will determine selection of PPE and respiratory protection. Remove PPE properly and wash hands.
	Decontamination area may become slippery.	Visually inspect work areas and mark, barricade, or eliminate slip, trip, and fall hazards as feasible. Maintain proper illumination in all work areas. If decontaminating on plastic sheeting, use caution since plastic sheeting is extremely slippery. Wear boots with good traction.

Notes:

CIH – Certified Industrial Hygienist

MSDS – Material Safety Data Sheet

PPE – personal protective equipment

SHSP – Site-Specific Health and Safety Plan

ATTACHMENT 3

FORMS



TETRA TECH FW, INC.

DAILY BRIEFING SIGN-IN SHEET

Date: _____ Project Name/Location: _____

Shift/Department: _____ Person Conducting Briefing: _____

1. AWARENESS (e.g., special EHS concerns, pollution prevention, recent incidents, etc.):

2. OTHER ISSUES (EHS Plan changes, attendee comments, etc.):

3. ATTENDEES (Print Name):

1.	21.
2.	22.
3.	23.
4.	24.
5.	25.
6.	26.
7.	27.
8.	28.
9.	29.
10.	30.
11.	31.
12.	32.
13.	33.
14.	34.
15.	35.
16.	36.
17.	37.
18.	38.
19.	39.
20.	40.

Daily Briefing Sign-In Sheet (Continued)

41.	56.
42.	57.
43.	58.
44.	59.
45.	60.
46.	61.
47.	62.
48.	63.
49.	64.
50.	65.
51.	66.
52.	67.
53.	68.
54.	69.
55.	70.

Give completed documentation to ESO.

SITE SAFETY BRIEFING FORM

Site: _____

Date: _____

Time: _____

OFS No.: _____

Task: _____ Health/Safety Officer: _____

Person Providing Briefing: _____

TOPICS:

- Site SHSP
- Chemical Hazards
- Equipment Hazards
- Electrical Hazards
- Heat Stress

- Personal Decontamination
- Personal Hygiene
- Employee Rights/Responsibilities
- Hazard Evaluations
- Emergency Response Procedures

PERSONS IN ATTENDANCE: (Name/Organization)

PERSONS IN ATTENDANCE: (Name/Organization)

NOTES/COMMENTS:

Date _____

[illegible]

MEDICAL DATA SHEET

Project: _____

Name: _____

Home Telephone Number: _____

Home Address: _____

Age: _____ Height: _____ Weight: _____ Blood Type: _____

Name of Emergency Contact: _____

Telephone Number of Emergency Contact: _____

Drug or Other Allergies: _____

Particular Sensitivities: _____

Do you wear contact lenses? _____

Provide a checklist of previous illness or exposures to hazardous chemicals: _____

What medications are you presently using? _____

Do you have any medical restrictions? If yes, explain: _____

Name, address, and phone number of personal physician:



TETRA TECH FW, INC.

TETRA TECH FW Inc
INCIDENT/NEAR MISS REPORT AND INVESTIGATION**TYPE OF INCIDENT - CHECK ALL THAT APPLY**

- | | | | |
|---|--|---|--------------------------------|
| <input type="checkbox"/> INJURY/ILLNESS | <input type="checkbox"/> VEHICLE DAMAGE | <input type="checkbox"/> PROPERTY DAMAGE | <input type="checkbox"/> FIRE |
| <input type="checkbox"/> SPILL/RELEASE | <input type="checkbox"/> PERMIT EXCEEDENCE | <input type="checkbox"/> HIGH LOSS POTENTIAL
(NEAR MISS) | <input type="checkbox"/> OTHER |

1. GENERAL INFORMATION

PROJECT/OFFICE:	REPORT #:	DATE OF REPORT:
DATE OF INCIDENT:	MILITARY TIME: _____	DAY OF WEEK: _____
FW SUPERVISOR ON DUTY:	AT SCENE OF INCIDENT: <input type="checkbox"/> YES <input type="checkbox"/> NO	
LOCATION OF INCIDENT:		
WEATHER CONDITIONS:	ADEQUATE LIGHTING AT SCENE:	<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> N/A

DESCRIBE WHAT HAPPENED (STEP BY STEP - use additional pages if necessary)**AFFECTED EMPLOYEE INFORMATION**

(Include injured person, driver/operator, or employee whose activities resulted in the incident. Use another page to provide information for additional employees)

NAME:	TTFW EMPLOYEE:	<input type="checkbox"/> YES <input type="checkbox"/> NO
HOME ADDRESS:		
SOCIAL SECURITY #:	HOME PHONE #:	
JOB CLASSIFICATION:	YEARS IN JOB CLASSIFICATION:	
HOURS WORKED ON SHIFT PRIOR TO INCIDENT:	YEARS WITH TTFW:	AGE:
DID INCIDENT RELATE TO ROUTINE TASK FOR JOB CLASSIFICATION: <input type="checkbox"/> YES <input type="checkbox"/> NO		

INJURY/ILLNESS INFORMATION**NATURE OF INJURY OR ILLNESS:****OBJECT/EQUIPMENT/SUBSTANCE CAUSING HARM:****FIRST AID PROVIDED:** ☐ YES ☐ NO**IF YES, WHERE WAS IT GIVEN:** ☐ ON SITE ☐ OFF SITE**IF YES, WHO PROVIDED FIRST AID:****WILL THE INJURY/ILLNESS RESULT IN:** ☐ RESTRICTED DUTY ☐ LOST TIME ☐ UNKNOWN

MEDICAL TREATMENT INFORMATIONWAS MEDICAL TREATMENT PROVIDED?: ☐ YES ☐ NOIF YES, WAS MEDICAL TREATMENT PROVIDED: ☐ ON SITE ☐ DR.'S OFFICE ☐ HOSPITAL

NAME OF PERSON(S) PROVIDING TREATMENT:

ADDRESS WHERE TREATMENT WAS PROVIDED:

TYPE OF TREATMENT:

VEHICLE AND PROPERTY DAMAGE INFORMATION

VEHICLE/PROPERTY DAMAGED:

DESCRIPTION OF DAMAGE:

SPILL AND AIR EMISSIONS INFORMATION

SUBSTANCE SPILLED OR RELEASED: FROM WHERE: TO WHERE:

ESTIMATED QUANTITY/DURATION:

CERCLA HAZARDOUS SUBSTANCE? YES ☐ NO ☐ RQ EXCEEDED? YES ☐ NO ☐ SPECIFY: _____REPORTABLE TO AGENCY? YES ☐ NO ☐ SPECIFY: _____WRITTEN REPORT? YES ☐ NO ☐ TIME FRAME: _____

RESPONSE ACTION TAKEN

PERMIT EXCEEDENCE

TYPE OF PERMIT: PERMIT #:

DATE OF EXCEEDENCE: DATE FIRST KNOWLEDGE OF EXCEEDENCE:

PERMITTED LEVEL OR CRITERIA (e.g., Water quality):

EXCEEDENCE LEVEL OR CRITERIA: EXCEEDENCE DURATION:

REPORTABLE TO AGENCY? YES ☐ NO ☐ SPECIFY: _____WRITTEN REPORT? YES ☐ NO ☐ TIME FRAME: _____

RESPONSE ACTION TAKEN:

NOTIFICATIONS

NAME(S) OF TTFW PERSONNEL NOTIFIED: DATE/TIME:

CLIENT NOTIFIED: DATE/TIME:

AGENCY NOTIFIED: DATE/TIME: ☐ NOT REQUIRED

CONTACT NAME:

PERSONS PREPARING REPORT

EMPLOYEE'S NAME: (PRINT) SIGN:

EMPLOYEE'S NAME (PRINT) SIGN:

SUPERVISOR'S NAME: (PRINT) SIGN:

NOTE: Supervisor to forward a copy of Incident Report to immediate supervisor, PESM, ESS or ESC, and other personnel as identified in Table 1 of this procedure ASAP, but no later than 24 hours.

INCIDENT SKETCH

VEHICLE INCIDENTS

Write in street names and, if possible, the points of the compass.

If a sketch appears on a police report or insurance form, this need not be completed. Attach the other report.

INVESTIGATIVE REPORT

DATE OF INCIDENT: _____

DATE OF INVESTIGATION REPORT: _____

INCIDENT COST: ESTIMATED: \$ _____ ACTUAL: \$ _____

OSHA RECORDABLE(S): ☐ YES ☐ NO # RESTRICTED DAYS _____ # DAYS AWAY FROM WORK _____

CAUSE ANALYSIS

Was the activity addressed in an AHA? ☐ YES (Attach a copy) ☐ NO

IMMEDIATE CAUSES – WHAT ACTIONS AND CONDITIONS CONTRIBUTED TO THIS EVENT? (USE NEXT PAGE)

BASIC CAUSES – WHAT SPECIFIC PERSONAL OR JOB FACTORS CONTRIBUTED TO THIS EVENT? (USE NEXT PAGE)

ACTION PLAN

REMEDIAL ACTIONS – WHAT HAS AND OR SHOULD BE DONE TO CONTROL EACH OF THE CAUSES LISTED? INCLUDE MANAGEMENT PROGRAMS (SEE ATTACHED LIST) FOR CONTROL OF INCIDENTS IF APPLICABLE.

ACTION	PERSON RESPONSIBLE	TARGET DATE	COMPLETION DATE

PERSONS PERFORMING INVESTIGATION

INVESTIGATOR'S NAME: (PRINT)	SIGN:	DATE:
INVESTIGATOR'S NAME: (PRINT)	SIGN:	DATE:
INVESTIGATOR'S NAME: (PRINT)	SIGN:	DATE:

MANAGEMENT REVIEW

PROJECT/OFFICE MANAGER (PRINT) SIGN:

COMMENTS:

PESM or ESC (PRINT) SIGN:

COMMENTS:

NOTE: Attach additional information as necessary. Supervisor to forward copy of Investigative Report to the PM or OM, PESM or ESC, ASAP, but no later than 72 hours after the incident. A copy shall be sent to the Director, Environmental Health and Safety Services within 24 hours of completion of the report.

EXAMPLES OF IMMEDIATE CAUSES

SUBSTANDARD ACTIONS

1. OPERATING EQUIPMENT WITHOUT AUTHORITY
2. FAILURE TO WARN
3. FAILURE TO SECURE
4. OPERATING AT IMPROPER SPEED
5. MAKING SAFETY DEVICES INOPERABLE
6. REMOVING SAFETY DEVICES
7. USING DEFECTIVE EQUIPMENT
8. FAILURE TO USE PPE PROPERLY
9. IMPROPER LOADING
10. IMPROPER PLACEMENT
11. IMPROPER LIFTING
12. IMPROPER POSITION FOR TASK
13. SERVICING EQUIPMENT IN OPERATION
14. UNDER INFLUENCE OF ALCOHOL/DRUGS
15. HORSEPLAY

SUBSTANDARD CONDITIONS

1. GUARDS OR BARRIERS
2. PROTECTIVE EQUIPMENT
3. TOOLS, EQUIPMENT, OR MATERIALS
4. CONGESTION
5. WARNING SYSTEM
6. FIRE AND EXPLOSION HAZARDS
7. POOR HOUSEKEEPING
8. NOISE EXPOSURE
9. EXPOSURE TO HAZARDOUS MATERIALS
10. EXTREME TEMPERATURE EXPOSURE
11. ILLUMINATION
12. VENTILATION
13. VISIBILITY

EXAMPLES OF BASIC CAUSES

PERSONAL FACTORS

1. CAPABILITY
2. KNOWLEDGE
3. SKILL
4. STRESS
5. MOTIVATION

JOB FACTORS

1. SUPERVISION
2. ENGINEERING
3. PURCHASING
4. MAINTENANCE
5. TOOLS/EQUIPMENT
6. WORK STANDARDS
7. WEAR AND TEAR
8. ABUSE OR MISUSE

MANAGEMENT PROGRAMS FOR CONTROL OF INCIDENTS

1. LEADERSHIP AND ADMINISTRATION
2. MANAGEMENT TRAINING
3. PLANNED INSPECTIONS
4. TASK ANALYSIS AND PROCEDURES
5. TASK OBSERVATION
6. EMERGENCY PREPAREDNESS
7. ORGANIZATIONAL RULES
8. ACCIDENT/INCIDENT ANALYSIS
9. PERSONAL PROTECTIVE EQUIPMENT

10. HEALTH CONTROL
11. PROGRAM AUDITS
12. ENGINEERING CONTROLS
13. PERSONAL COMMUNICATIONS
14. GROUP MEETINGS
15. GENERAL PROMOTION
16. HIRING AND PLACEMENT
17. PURCHASING CONTROLS

NOTIFICATION REMINDER

Fatalities or hospitalization (admittance) of three or more individuals requires notification to OSHA within 8 hours. Contact the Director, Health and Safety Programs or Director, ESQ Programs to make the notification. If unavailable, the senior operations person on site should make the notification.

Incident/Near Miss Report and Investigation Instructions

General: The incident report (pages 1 and 2) must be completed within 24 hours. Do not delay the report if any information is unknown. It can be provided later by revising the Report.

Type of Incident: Check all that apply. A High Loss Potential (Near Miss) incident is one that does not result in loss, but under slightly different circumstances, could have resulted in an OSHA Recordable injury, spill, release, permit exceedence, fire, or vehicle/property damage in excess of \$500. All High Loss Potential (Near Miss) incidents are to be investigated.

General Information

Project/Office: If the incident occurs on a delivery order contract, give the contract/program name, DO# and location. If the incident occurs on a C&E field project, give the Office location managing the project as well as the project/location.

Report No.: Optional numbering field for offices/projects.

TTFW Supervisor: The TTFW supervisor responsible for the work effort involving the incident. Do not give a subcontractor supervisor or craft foreman name. If a TTFW Supervisor was the Affected Employee, this field should contain the name of his or her supervisor. The Supervisor is the project supervisor if the incident happens on a project, or the administrative supervisor if the incident happens in the office. E.g., a geologist, acting as an FOL gets injured on a job site, or in a motor vehicle in the course of project work. The FW Supervisor is most likely the Project Manager. If the same geologist gets injured lifting a box in his office, the FW Supervisor is likely the Office Science Lead.

Location of Incident: The specific location on the project, in the office, or off-site location.

Weather Conditions: Temperature, precipitation, approximate wind speed and direction, cloud cover, relative humidity. This information may be included in the description section, and must be given in detail whenever it is a factor in the cause or impact, e.g., spill, release, heat stress, wind blown material.

Describe What Happened: This section must be completed in sufficient detail to adequately describe the events and conditions leading up to and resulting from the incident. Try to answer the questions who, what, where, when, and how. This information is then used to determine why (cause). Provide details such as work objective, procedure being used, body position, and PPE. Include diagrams or sketches for all incidents involving vehicles/equipment and other incidents where they aid in providing detail or perspective. Consider including photographs. Follow the guidelines in Practical Loss

Control Leadership, and consider the impact of each of the following:

P - People
E - Equipment
M - Material
E - Environment

To do an effective job, a visual inspection of the scene is usually necessary along with private interviews of affected employees and witnesses.

Where appropriate, use terms indicating the type of contact, e.g., struck by; struck against; fall from elevation; fall on same level; caught in; caught between or under; caught on; contact with; overstress; equipment failure; environmental release; fire.

Affected Employee Information

TTFW Employee: Direct hire, whether professional, administrative, or craft; full-time or part-time; permanent or temporary. If the affected employee is not a TTFW employee, give the name of the employer and business relationship (e.g., client, subcontractor) in the description section above.

Hours Worked on Shift Prior to the Incident: Only include the amount of time the employee worked that shift or day prior to the incident.

Years with TTFW: For TTFW employees, give the number of years employed with TTFW. If the employee has worked for TTFW for less than a year, do not write <1. Give the answer in fraction of year, or specify the number of months, e.g., 0.1 or 1 month.

Injury/Illness Information

Nature of Injury or Illness: If the incident resulted in an injury or illness, give a brief description of the body part affected and type of injury or illness, e.g., fractured thumb, left hand; carpal tunnel syndrome, right hand.

First Aid Provided: First Aid is any treatment that does not have to be provided by a health care professional, even if it is. E.g., a laceration that is cleaned and bandaged in a clinic may constitute first aid, if sutures are not given.

Will the Injury Result In: Do not delay the report if this information is unknown.

Medical Treatment Information

Was Medical Treatment Provided? Medical treatment is that treatment that must be provided by a licensed medical practitioner, e.g., sutures, prescription medication, etc.

Type of Treatment: This information is important in determining OSHA recordability, since some forms of treatment would not constitute a Recordable case (e.g., one-time administration of prescriptions, negative diagnostic exams). Attach a copy of the treating professional's statement/work release.

Vehicle and Property Damage Information

Vehicle/Property Damaged: For vehicles, indicate VIN and whether it is company owned or leased, business trip rental (Avis) or owned by others.

Description of Damage: Be specific as to the identity of damaged part, location and extent.

Spill and Air Emissions Information

Substance Spilled or Released: For pure substances, list materials by common name/chemical. For wastes, indicate waste code. For mixtures or contaminated media, provide contaminant name, CAS No., concentration.

Exceeded? Reportable quantity. Contact your ESQ representative for guidance. Specify the RQ for the material, whether you answer yes or no.

Reportable to Agency? If yes, specify the federal, state or local agency that must be provided with verbal and/or written notification.

Written Report? Answer yes if the release requires a written report to be filed and note the time frame.

Response Action Taken: Describe the mitigation efforts, as well as any reports made, beyond initial notification.

Permit Exceedence

Type of Permit: List name of permit including the agency name where applicable (e.g., NPDES, PSAPCA NOC)

Date of Exceedence: Specify date exceedence occurred (e.g., date discharge in excess of permit limits occurred)

Date First Knowledge of Exceedence: Specify date when first knew there was an exceedence (i.e., date analytical received). This date may be different from the date of the exceedence listed above.

Permitted Level or Criteria: List numerical discharge or emission limit or narrative criteria specified in the permit (e.g.,

20% opacity limit, Best Management Practices (BMP) implementation per SWPPP).

Exceedence Level or Criteria: Specify actual numerical discharge/emission limit or narrative criteria which was exceeded (e.g., 22% opacity, failure of BMPs (silt fencing collapse) per SWPPP)

Exceedence Duration: Specify time frame by date and hours (using military time) during which exceedence occurred.

See "Spill/Release Information" (above) for description of remaining questions.

Persons Preparing Report

Employee's Name: The affected employee described on page 1 should review the report and sign here, as well as other employees witnessing or involved in the incident.

Supervisor's Name: The TTFW Supervisor must review and sign the report indicating agreement. The TTFW Supervisor and the Investigator (next page) should be the same person.

Investigative Report

Report No.: This is the same as the project/office optional report number from page 1 of the Incident/Near Miss Report.

Date of Investigative Report: This date should be within 72 hours of the incident. In cases where the investigation is not completed until a later date, submit the incomplete report within the 72 hours, and a revised report should be submitted when the missing information is obtained.

Incident Cost: For all vehicle/equipment or property damage cases, an estimated or actual loss value must be entered. If an estimated value is entered, the report must be revised when the actual costs are known.

OSHA Recordables: This section should be completed in consultation with the PESM. If it cannot be determined at the time of the report, the PESM should consult with the Director, Health and Safety Programs and revise the report when a determination is made.

No. of Restricted Days: This relates to days of restricted work activity, not restrictions on motion or physical capability. If the employee is capable of doing his normal job the day after the injury and thereafter, there are no restricted days, even if the physician indicates a physical restriction. It does not include the day of the injury.

No. of Days Away from Work: The number of days after the day of the injury that the employee was scheduled to work but could not due to an occupational injury. If the treating physician releases an employee to return to work, but the employee chooses not to come to work, do not count those

days. In this case the PESM should contact the Director, Health and Safety Programs.

Cause Analysis

Immediate Causes: Determine the immediate causes, using the example on page 4. If one or more of the examples fits the circumstance, use those words in the cause description. This facilitates statistical analysis of the incident database for program evaluation/modification. However, do not confine your cause determination to the guide words. Explain, e.g., Improper Lifting – employee attempted to lift box by bending at the waist and twisting while lifting. Be sure that the incident description on page 1 is sufficiently detailed to support the causal analysis in this section. An assumption of cause (e.g., improper lifting) from the injury (low back pain) is not acceptable.

Basic Causes: Like the Immediate Causes, use the guide words in the attachment whenever appropriate and explain. For example, improper motivation may be because the correct way takes more time or effort; short cutting standard procedure is tolerated or positively reinforced; or the person thinks there is no personal benefit to always doing the job correctly.

Note: The investigator is encouraged to review the Practical Loss Control Leadership chapters on *Causes and Effects of Loss* and *Accident/Incident Investigation* before doing the causal analysis. As a check, the investigator may refer to the C.A.T. Chart available from the PESM.

Remedial Actions: Include all actions taken or those that should be taken to prevent recurrence. Be sure that actions address the causes. For example, training (safety meetings) may be a necessary response for lack of knowledge, but may be inadequate for improper motivation. If completion dates exceed the 72 hours reporting period, a revised report must be submitted when all remedial actions are complete.

Persons Performing Investigation: The primary investigator is the TTFW Supervisor in charge of the work where the incident occurred. Others participating in the investigation, such as the Project Manager, ESS, QC, site engineer, foreman, etc. should also sign the report.

Management Review: The Project or Office Manager and the PESM or office ESC must sign the report indicating their satisfaction with thoroughness of the investigation and the report, and their concurrence that the action items address the identified causes. This constitutes the peer review, and the report, particularly the description, should be clear to readers not familiar with the project or incident.



TETRA TECH FW, INC.

SITE SAFETY PLAN CHANGE APPROVAL FORM

N68711-98-D-5713

CTO: _____

Date _____ Amendment Number _____

Project Name: _____ Project Number: _____

Section of SHSP: _____ Page Number: _____

Change to read: _____

Reason for change: _____

Approvals:

Project Superintendent or Manager

SSHS

PESM (CIH)

SAFETY INSPECTION CHECK LIST FOR CONSTRUCTION EQUIPMENT

(Including Cranes, Derricks, and Hoisting Equipment)

PROJECT	CONTRACTOR	CONTRACT NO.
TYPE AND MAKE OF EQUIPMENT	MODEL	SERIAL NO.

Before any machinery or mechanized equipment is placed in use, it shall be inspected and tested by a competent mechanic and certified to be in good operating condition. Records of tests and inspections shall be maintained as part of the active contract file at Project or Resident Office. Check list set forth herein requires the application of EM 385-1-1, Safety and Health Requirements Manual, 1 Oct 87. The appropriate EM paragraph to be applied is listed at the end of each testing requirement.

CHECK LIST	Yes	No	Not Appl
1. ARE ADEQUATE AND SERVICEABLE FIRE EXTINGUISHERS PROVIDED? (13.A.01)			
2. ARE ALL WIRE ROPE CABLES IN GOOD CONDITION? (17.C.01)			
3. ARE WIRE ROPE, SOCKETS, SPLICES, THIMBLES AND CLIPS ADEQUATE AND PROPERLY APPLIED? (17.C.09)			
4. ARE HOOKS, SAFETY NOOKS, SHACKLES, RINGS, ETC., IN GOOD CONDITION? (17.A.02, 17.A.05)			
5. ARE NECESSARY PLATFORMS, FOOTWALKS, ETC., PROVIDED? (18.B.08)			
ARE ACCESS STEPS, PLATFORMS, ETC., PROVIDED WITH NON-SLIP SURFACES? (18.B.08, 18.A.14, (28.B.03)			
7. IS OPERATOR PROTECTED AGAINST THE ELEMENTS, FALLING OR FLYING OBJECTS, SWINGING LOADS, AND SIMILAR HAZARDS? (18.B.18, 19.A.13, 18.B.19, 18.B.21)			
8. ARE ALL GLASSES IN OPERATOR'S COMPARTMENT SAFETY GLASS AND IN GOOD REPAIR? (19.A.15, 19.A.16, 18.B.18)			
9. IS SUITABLE ACCESS PROVIDED TO LUBRICATION POINTS? (18.A.18)			
10. DO ALL MODIFICATIONS, EXTENSIONS, REPLACEMENT PARTS, AND/OR REPAIRS TO EQUIPMENT MAINTAIN THE SAME FACTOR OF SAFETY AS ORIGINAL DESIGNED EQUIPMENT? (18.A.33, 18.C.04)			
11. ARE DRUMS FOR LOAD LINES EQUIPPED WITH AT LEAST ONE POSITIVE HOLDING DEVICE, APPLIED DIRECTLY TO THE MOTOR SHAFT OR SOME PART OF THE TRAIN GEAR? (18.C.06)			
12. IS THERE SUFFICIENT CABLE TO ALLOW TWO FULL WRAPS OF CABLE ON DRUMS AT ALL WORKING POSITIONS? (18.C.07)			
13. ARE ADEQUATE HEADLIGHTS, TAIL-LIGHTS AND TURN SIGNALS PROVIDED AND ARE THEY IN PROPER OPERATING CONDITION? (19.A.06, 18.A.15)			
14. ARE ALL APPROVED BRAKES ON WHEELED EQUIPMENT AND IN GOOD OPERATING CONDITION? (18.A.21, 18.A.22, 19.A.07, 19.A.08)			
15. DO WINDSHIELDS HAVE WIPERS IN PROPER OPERATING CONDITION? (19.A.10, 18.A.29)			
16. ARE REAR VIEW MIRRORS PROVIDED? (19.A.12)			
ARE OPERATING LEVERS EQUIPPED WITH LATCH OR OTHER DEVICES TO PREVENT ACCIDENTAL STARTING? (19.A.21)			

DRILLING EQUIPMENT			
Contract Name and Number:		Contractor/Subcontractor:	
Government Inspector:		Location:	
Contractor Inspector:		Date:	
Equipment name and number:			
	Yes	No	N/A
1. Is a copy of the manual for all drilling equipment available? (16.M.02)			
2. Has a survey been conducted to identify overhead electrical hazards and potential ground hazards and their locations identified in the site layout plan? (16.M.03)			
3. Does the hazard analysis contain copies of Material Safety Data Sheets for all drilling fluids available? (16.M.03a)			
4. Have all members of the drilling crew been trained the operation, inspection, and maintenance of the equipment; the safety features and procedures to be used; and overhead electrical lines and underground hazards? (16.M.04a)			
5. Does the drilling equipment have two easily accessible emergency shut down devices (one for the operator and one for the helper)? (16.M.05)			
6. Is the equipment posted with a warning of electrical hazards? (16.M.06a)			
7. Is there a spotter or an electrical proximity warning device available to ensure safe distances from power lines are maintained? (16.M.06b)			
8. Before moving earth drilling equipment, has the travel route been surveyed for overhead and terrain hazards, particularly overhead electrical hazards? (16.M.07a)			
9. Is equipment set-up in a stable manner, with cribbing if necessary? (16.M.08a)			
10. Are outriggers being used in accordance with the manufacturer's recommendations? (16.M.08b)			
11. Are drill crew members prohibited from wearing loose clothing, jewelry, or equipment which might become caught in moving machinery? (16.M.09b)			
12. Are steps being taken to control dust? (16.M.09i)			
13. Are augers cleaned only when the rotating mechanism is in neutral and the auger is stopped? (16.M.09j)			
14. Means shall be provided to guard against employee contact with auger. (guard around the auger; barricade around the perimeter of the auger; electronic brake activated by a presence-sensing device). 16.M.10l			
Comments:			

This checklist is based on EM 385-1-1, dated 3 September 1996. Use of this checklist is optional.

MACHINERY AND MOBILE EQUIPMENT
(BACKHOES, DOZERS, SCRAPERS, EXCAVATORS, LIFT TRUCKS, etc.)

Contract Name and Number:	Contractor/Subcontractor:
Government Inspector:	Location:
Contractor Inspector:	Date:

Equipment name and number:

Complete one checklist for each piece of equipment.	Yes	No	N/A
1. Is the slow moving emblem used on all vehicles which by design move at 25 mph or less on public roads? (08.A.04)			
2. Are initial and daily/shift inspection records available? (16.A.01 and .02)			
3. When machinery or equipment is found to be unsafe or when a deficiency which affects the safe operation of equipment is observed, is the equipment immediately taken out of service and its use prohibited until unsafe conditions have been corrected? (16.A.03)			
4. Is machinery or equipment operated only by designated personnel? (16.A.04)			
5. Have inspections or determinations of road conditions and structures been made in advance to assure that clearances and load capacities are safe for the passage or placing any machinery or equipment? (16.A.06)			
6. Are seats or equal protection provided for each person required to ride on the equipment? (16.A.07a)			
7. Is equipment operating on streets and highways equipped with headlights, taillights, brake lights, back light, and turn signals (visible from front and rear)? (16.A.07b)			
8. Is all equipment equipped with operable windshield wipers, and defrosting or defogging equipment? (16.A.07c)			
9. Does the unit have an emergency brake which will automatically stop the equipment upon brake failure? Is this system manually operable from the drivers position? (16.A.07d)			
10. Is all maintenance (including preventive maintenance) and repairs done in accordance with the manufacturer's recommendations and is it documented? (16.A.08a)			
11. Has bulldozer and scraper blades, end-loader buckets, dump bodies, and similar equipment been fully lowered or blocked when being repair or when not in use? (16.A.09)			
12. Has adequate ventilation been provided when equipment powered by internal combustion engines is operating in enclosed areas? (16.A.12)			
13. Are all vehicles which will be parked or moving slower than normal traffic on haul roads equipped with a yellow flashing light or flasher visible from all directions? (16.A.13)			
14. Is all mechanized equipment shut down before and during refueling? (16.A.14)			
15. Are all towing devices used on any combination of equipment structurally adequate for the weight drawn and securely mounted? (16.A.15a)			
16. Have the wheels been chocked or track mechanisms blocked and the parking brake set when equipment is parked on an incline? (16.A.17b)			

This checklist is based on EM 385-1-1, dated 3 September 1996. Use of this checklist is optional.

MACHINERY AND MOBILE EQUIPMENT (con.)

	Yes	No	N/A
17. Are personnel prohibited from working or passing under or riding in the buckets or booms of loaders in operation? (16.A.24)			
18. Does the unit have a dry chemical or carbon-dioxide fire extinguisher with a minimum rating of 5-B:C? (16.A.26)			
19. Is there an effective, working reverse alarm? (16.B.01)			
20. Is there a signalperson or warning device when there is a danger to persons from moving equipment, swinging loads, buckets, booms, etc.? (16.B.02)			
21. Are all belts, gears, shafts, pulleys, sprockets, spindles, drums, flywheels, chains, or other reciprocating, rotating, or moving parts guarded? (16.B.03a)			
22. Is protection against hot surfaces, exhausts, etc., provided? (16.B.03b)			
23. Are platforms, footwalks, steps, handholds, guardrails, and toeboards designed, constructed, and installed on machinery and equipment to provide safe footing and accessways? (16.B.03d)			
24. Are fuel tanks located in a manner to prevent spills or overflows from running onto engine exhaust or electrical equipment? (16.B.04)			
25. Are exhaust or discharges from equipment directed so they do not endanger persons or obstruct operator vision? (16.B.05)			
26. Are seatbelts installed and worn in all motor vehicles? (16.B.08)			
27. Is protection (grills, canopies, screens) provided to shield operator from falling or flying objects? (16.B.10 and .11)			
28. Is roll over protection provided? (16.B.12)			

Comments:

This checklist is based on EM 385-1-1, dated 3 September 1996. Use of this checklist is optional.

MACHINERY & MECHANIZED EQUIPMENT CERTIFICATION FORM

From: (Contractor)

(Sub-Contractor)

Contract No. _____ Title:

To: Contracting Officer: ROICC COTR

Subj: SAFETY CERTIFICATION OF MACHINERY AND MECHANIZED EQUIPMENT

Ref: (a) U. S. Army Corps of Engineers. EM 385-1-1
Safety and Health Requirements Manual

1. Inspection and certification of machinery and mechanized equipment, as required by reference (a) has been made as shown below:

a. Identification of equipment

(1) _____ Date

(2) _____ Date

(3) _____ Date

(4) _____ Date

(5) _____ Date

2. The above listed equipment is CERTIFIED TO BE IN SAFE OPERATING CONDITION BY A COMPETENT PERSON and as outlined in reference (a).

Name, Title, and signature of competent mechanic making the inspection:

Name _____ Title

Firm

Signature

Copy to :
Contract File

- ☐ Initial Report
☐ Follow-up Report
☐ Final Report

Contractor Significant Incident Report (CSIR)

1. General Information		
Contracting Activity/ROICC Office:		
Accident Classification: <input type="checkbox"/> Injury <input type="checkbox"/> Fatality <input type="checkbox"/> Environment <input type="checkbox"/> Procedural Issues <input type="checkbox"/> Lessons Learned <input type="checkbox"/> Illness <input type="checkbox"/> Property Damage <input type="checkbox"/> Other _____		
Involving: <input type="checkbox"/> Confined Space <input type="checkbox"/> Equip/Mrt Ver/Mat Handling (Heavy Construction Equip.) <input type="checkbox"/> Hazardous Material <input type="checkbox"/> Crane and Rigging <input type="checkbox"/> Equip/Mrt Ver/Mat Handling (Material Handling) <input type="checkbox"/> Trenching/Excavation <input type="checkbox"/> Diving <input type="checkbox"/> Equip/Mrt Ver/Mat Handling (Man-Lift/Elevated Platform) <input type="checkbox"/> Waterfront/Marine <input type="checkbox"/> Demolition/Renovation <input type="checkbox"/> Fall from Ladder <input type="checkbox"/> Fall from Scaffold <input type="checkbox"/> Other _____ <input type="checkbox"/> Electrical <input type="checkbox"/> Fall from Roof <input type="checkbox"/> Fire		
2. Personal Information		
Name (Last, First, MI):	Age:	Sex:
Job Title/Description:	Employed By:	
Supervisor Name (Last, First, MI) & Title:	Was the person trained to perform this activity/task? <input type="checkbox"/> Yes <input type="checkbox"/> No	
What type of training was received (OJT, classroom, etc)?	Date of the most recent formal training and topics discussed?	
3. Witness Information		
Witness #1: Name (Last, First, MI):	Job Title/Description:	
Employed By:	Supervisor Name (Last, First, MI):	
Witness #2: Name (Last, First, MI):	Job Title/Description:	
Employed By:	Supervisor Name (Last, First, MI):	
Additional Witnesses: <input type="checkbox"/> Yes <input type="checkbox"/> No (List any additional witnesses on a separate sheet and attach.)		

4. Contract Information

Type of Contract:

☐ A/E ☐ BOS ☐ CLEAN ☐ Construction ☐ Design Build ☐ FSCC ☐ FSSC
☐ JOC ☐ RAC ☐ Service ☐ Other _____

Contract Number & Title:

Industrial Group & Industrial Type:

Prime Contractor Name/Address/Phone & Fax No:

Sub Contractor Name/Address/Phone & FAX No:

Safety Manager (Last, First, MI):

Safety Manager (Last, First, MI):

Insurance Carrier:

Insurance Carrier:

5. Accident Description

Date of Accident:

Time of Accident:

Exact Location of Accident:

Describe the accident in detail in your words: *(Use the back of page if you need additional space)*

Direct Cause(s) of Accident:

Indirect Cause(s) of Accident:	
Action(s) taken to prevent re-occurrence or provide on-going corrective actions:	
Corrective Action Beginning Date:	Anticipated Completion Date:
Personal Protective Equipment: <div style="display: flex; justify-content: space-between; margin-top: 10px;"> <input type="checkbox"/> Available and used <input type="checkbox"/> Available and not used <input type="checkbox"/> Not Required </div> <div style="display: flex; justify-content: space-between; margin-top: 10px;"> <input type="checkbox"/> Not related to Mishap <input type="checkbox"/> Wrong PPE for job </div> <div style="margin-top: 20px;"> List PPE Used: </div>	
Type of Construction Equipment (Make, Model, Serial #, VIN#) Involved:	
<div style="display: flex; justify-content: space-between;"> Was Hazardous Material Spilled/Released? <input type="checkbox"/> Yes <input type="checkbox"/> No </div> <div style="margin-top: 10px;"> Please List Hazardous Material(s) Involved: </div>	
Who provided first aid or cleanup of mishap site?	
<div style="display: flex; justify-content: space-between;"> Any blood-borne pathogen exposure, other than EMTs? <input type="checkbox"/> Yes <input type="checkbox"/> No </div> <div style="margin-top: 10px;"> Who? </div>	
List OSHA and EM-385-1-1 standards that were violated:	
<div style="display: flex; justify-content: space-between;"> Was site secured and witness statements taken immediately? <input type="checkbox"/> Yes <input type="checkbox"/> No </div> <div style="margin-top: 10px;"> By Whom? </div>	

6. Injury Illness/Fatality Information**Severity of Injury/Illness:**

- | | |
|---|---|
| <input type="checkbox"/> Fatality | <input type="checkbox"/> Lost Workday Case Involving Days Away From Work |
| <input type="checkbox"/> Temporary Disability | <input type="checkbox"/> Recordable Workday Case Involving Restricted Duty |
| <input type="checkbox"/> Permanent Total Disability | <input type="checkbox"/> Other Recordable Case <input type="checkbox"/> Recordable First Aid Case |
| <input type="checkbox"/> Permanent Partial Disability | <input type="checkbox"/> Non-Recordable Case <input type="checkbox"/> No Injury |

Estimated Days Lost:**Estimated Days Hospitalized:****Estimated Days Restricted Duty:****List Primary Body Part Affected:****List Other Body Part(s) Affected:****Nature of Injury/Illness for Primary Body Part (Examples: Amputation, Burn, Hernia):****Type of Accident (Examples: Fall same level, Lifting, Bitten, Exerted):****Source of Accident (Examples: Crane, Carbon Monoxide, Ladder, Welding Equipment):****7. Causal Factors (Explain answers on supplementary sheet)**

• Design – Design of facility, workplace, or equipment was a factor?	<input type="checkbox"/> Yes <input type="checkbox"/> No
• Inspection/Maintenance – Inspection & Maintenance procedures were a factor?	<input type="checkbox"/> Yes <input type="checkbox"/> No
• Persons Physical Condition – In your opinion, the physical condition of the person was a factor?	<input type="checkbox"/> Yes <input type="checkbox"/> No
• Operation Procedures – Operating procedures were a factor?	<input type="checkbox"/> Yes <input type="checkbox"/> No
• Job Practices – One or more job safety/health practices not being followed when the accident occurred contributed to the accident?	<input type="checkbox"/> Yes <input type="checkbox"/> No
• Human Factors – One or more human factors, such as a person's size or strength contributed to the accident?	<input type="checkbox"/> Yes <input type="checkbox"/> No
• Environmental Factors – Heat, cold, dust, sun, glare, etc., contributed to the accident?	<input type="checkbox"/> Yes <input type="checkbox"/> No
• Chemical and Physical Agent Factors – Exposure to chemical agents, such as dust, fumes, mist, vapors, or physical agents such as noise, radiation, etc., contributed to the accident?	<input type="checkbox"/> Yes <input type="checkbox"/> No
• Office Factors – Office setting such as lifting office furniture, carrying, stooping, contributed to the accident?	<input type="checkbox"/> Yes <input type="checkbox"/> No
• Support Factors – Inappropriate tools/resources were provided to perform the task?	<input type="checkbox"/> Yes <input type="checkbox"/> No
• PPE – Improper selection, use or maintenance of PPE contributed to the accident?	<input type="checkbox"/> Yes <input type="checkbox"/> No
• Drugs/Alcohol – In your opinion, were drugs or alcohol a factor?	<input type="checkbox"/> Yes <input type="checkbox"/> No
• Job Hazard Analysis – The lack of an adequate (IAW-EM-385-1-1 Sec 01.A) activity hazard analysis was a contributing factor.	<input type="checkbox"/> Yes <input type="checkbox"/> No
• Job Hazard Analysis – JHA was not site specific and/or did not address the type of work/operations performed when the mishap occurred.	<input type="checkbox"/> Yes <input type="checkbox"/> No
• Management – A lack of adequate supervision contributed to the accident.	<input type="checkbox"/> Yes <input type="checkbox"/> No
• Management – Inadequate information was provided at pre con meeting.	<input type="checkbox"/> Yes <input type="checkbox"/> No

8. OSHA Information			
Date OSHA was Notified:	Date(s) of Investigation:	Date of citation: (Attach Copy)	Dollar amount of Penalties:
9. Report Preparer			
Name (Last, First, MI):		Date of Report:	
Title: Employer: Phone #:		Signature:	

CONTRACTOR SIGNIFICANT INCIDENT REPORT (CSIR) INSTRUCTIONS

Complete Sections Appropriate to Incident (Rev. 06/02).

NOTE: THE ATTACHED CSIR FORM IS TO BE USED BY CONTRACTORS TO RECORD THE RESULTS OF THEIR ACCIDENT/INCIDENTS INVESTIGATIONS AND SHALL BE PROVIDED TO THE CONTRACTING OFFICER WITHIN THE REQUIRED TIMEFRAMES.

GENERAL. Complete a separate report for each person who was injured in the accident. A report needs to be completed for all OSHA recordable accidents, property damage in excess of \$2000.00 (This amount is for record purposes only. GOV is not required to enter property damage reports into FAIR database if it is less than \$10,000.00.), WHE accidents, or near miss/high visibility mishaps. Please type or print legibly. Appropriate items shall be marked with an "X" in box(es), non-applicable sections shall be marked "N/A". If additional space is needed, provide the information on a separate sheet of paper and attach to the completed form.

Mark the report:

INITIAL – If this form is being used as initial notification of a Fatality or High Visibility Mishap. The initial form is due within 4 hours of a serious accident. A form marked 'Follow-up' or 'Final' is required within 5 days.

FOLLOW-UP – If you are providing additional information on a report previously submitted.

FINAL – If you are providing a completed report and expect no changes.

SECTION 1 – GENERAL INFORMATION

CONTRACTING ACTIVITY/ROICC OFFICE - Enter the name and address of the Contracting Office administering the contract under which the mishap took place (e.g. ROICC MCBH, ROICC NORFOLK, PWC GUAM, etc.).

ACCIDENT CLASSIFICATION - INJURY/ILLNESS/FATALITY/PROPERTY DAMAGE/-PROCEDURAL ISSUES/-ENVIRONMENTAL/LESSONS LEARNED/OTHER – Mark the appropriate block(s) if the incident resulted in any of these conditions.

INVOLVING - If the mishap involved any of the conditions listed under "Involving" mark the appropriate box(es). Specific questions associated with each of these conditions are available from the Contracting Officer to assist you in your investigation. When these questions are used they shall be attached as part of this report.

SECTION 2 - PERSONAL INFORMATION

NAME - Enter last name, first name, middle initial of person involved.

AGE - Enter age.

SEX - Enter M for Male and F for Female.

JOB TITLE/DESCRIPTION - Enter the job title/description assigned to the injured person (e.g. carpenter, laborer, surveyor, etc.).

EMPLOYED BY - Enter employment company name of the person involved.

SUPERVISOR'S NAME & TITLE - Enter name and title of the immediate supervisor.

WAS PERSON TRAINED TO PERFORM ACTIVITY/TASK? - For the purpose of this section "trained" means the person has been provided the necessary information (either formal and/or on-the-job (OJT) training) to competently perform the activity/task in a safe and healthful manner.

TYPE OF TRAINING - Indicate the specific type of training (classroom or on-the-job) that the injured person received before the accident happened.

DATE OF MOST RECENT FORMAL TRAINING/TOPICS DISCUSSED - Enter the month, day, and year of the last *formal* training completed that covered the activity/task being performed at the time of the accident. List topics that were discussed at the training identified above.

SECTION 3 - WITNESS INFORMATION

The following applies to Witness #1 and Witness #2:

WITNESS NAME - Enter last name, first name, middle initial of the witness.

JOB DESCRIPTION/TITLE - Enter the job title/description assigned to the witness (e.g. carpenter, laborer, surveyor, etc.).

EMPLOYED BY - Enter the name of the employment company of the witness.

SUPERVISORS NAME - Enter name of immediate supervisor of the witness.

ADDITIONAL WITNESSES - Provide same information, as above, for each witnesses. Use additional pages if necessary.

SECTION 4 - CONTRACTOR INFORMATION

TYPE OF CONTRACT - Mark appropriate box. A/E means architect/engineer. If "OTHER" is marked, specify type of contract on line provided.

CONTRACT NUMBER/TITLE - Enter complete contract number and title of prime contract (e.g. N62477-85-C-0100, 184 Pearl City Hsg. Revitalization).

CONSTRUCTION INDUSTRIAL GROUP AND INDUSTRIAL TYPE – This is the type of construction that will be done at this project.

1. First, you must choose the Industrial Group. You have 4 choices to choose from: (NOTE! Review of the Industrial Types below and knowing what the projects scope of work is will assist you in deciding what the Industrial Group should be.)

- a. Buildings
- b. Heavy Industrial
- c. Infrastructure
- d. Light Industrial

2. Once you have chosen the Industrial Group, you now select the Industrial Type. You have multiple choices under each Group, chose the one you feel fits the project most closely because on most projects there won't be an exact match:

- a. Buildings:
 - (1) Communications Ctr.
 - (2) Dormitory/Hotel
 - (3) High-rise Office
 - (4) Hospital
 - (5) Housing
 - (6) Laboratory
 - (7) Low-rise Office
 - (8) Maintenance Facility
 - (9) Parking Garage
 - (10) Physical Fitness Ctr.
 - (11) Restaurant/Nightclub
 - (12) School
 - (13) Warehouse
- b. Heavy Industrial:
 - (1) Chemical Mfg.
 - (2) Electrical (Generating)
 - (3) Environmental
 - (4) Metals Refining/Processing
 - (5) Mining
 - (6) Natural Gas Processing
 - (7) Oil Exploration/Production
 - (8) Oil Refining
 - (9) Pulp and Paper
- c. Infrastructure:
 - (1) Airport
 - (2) Electrical Distribution
 - (3) Flood Control
 - (4) Highway
 - (5) Marine Facilities
 - (6) Navigation
 - (7) Rail
 - (8) Tunneling
 - (9) Water/Wastewater
- d. Light Industrial:
 - (1) Automotive Assembly/Mfg.
 - (2) Consumer Products Mfg.
 - (3) Foods
 - (4) Microelectronics Mfg.
 - (5) Office Products Mfg.
 - (6) Pharmaceuticals Mfg.

CONTRACTOR'S NAME/ADDRESS/PHONE NUMBER

- (1) PRIME - Enter the exact name (title of firm), address, phone and fax numbers of the prime contractor.
- (2) SUBCONTRACTOR - Enter the exact name, address, phone and fax numbers of any subcontractor involved in the accident.

SAFETY MANAGER'S NAME

- (1) PRIME - Enter the name of the prime contractor safety manager.
- (2) SUBCONTRACTOR - Enter the name of the subcontractors safety manager.

INSURANCE CARRIER

- (1) PRIME - Enter the exact name/title of the prime's insurance company. Policy number not required.
- (2) SUBCONTRACTOR - Enter the exact name of the subcontractor's insurance company. Policy number not required.

SECTION 5 - ACCIDENT DESCRIPTION

DATE OF ACCIDENT - Enter the month, day, and year of accident.

TIME OF ACCIDENT - Enter the local time of accident in military time. Example: 14:30 hrs (not 2:30 p.m.).

EXACT LOCATION OF ACCIDENT - Enter facts needed to locate the accident scene (installation/project name, building/room number, street, direction and distance from closest landmark, etc.).

DESCRIBE THE ACCIDENT IN DETAIL. Fully describe the accident in the space provided. If property damage involved, give estimated dollar amount of damage and/or repair costs involved. If additional space is needed continue on a separate sheet and attach to this report. Give the sequence of events that describe what happened leading up to and including the accident. Fully identify personnel and equipment involved and their role(s) in the accident. Ensure that relationships between personnel and equipment are clearly specified. Ensure questions below regarding direct cause(s), indirect cause(s), and actions taken are answered. **NOTE!** Review questions in Section 7 below before completing.

DIRECT CAUSE(S) - The direct cause is that single factor which most directly lead to the accident. See examples below.

INDIRECT CAUSE(S) - Indirect cause are those factors, which contributed to, but did not directly initiate the occurrence of the accident.

Examples for Direct and Indirect Cause:

- 1. Employee was dismantling scaffold and fell 12 feet from unguarded opening.

Direct cause: Failure to provide fall protection at elevation

Indirect causes: Failure to enforce safety requirements: improper training/motivation of employee (possibility that employee was not knowledgeable of fall protection requirements or was lax in his attitude toward safety); failure to ensure provision of positive fall protection whenever elevated; failure to address fall protection during scaffold dismantling in phase hazard analysis.

2. Private citizen had stopped his vehicle at intersection for red light when vehicle was struck in rear by contractor vehicle. (note contractor vehicles was in proper safe working condition.)

Direct cause: Failure of contractor driver to maintain control of and stop contractor vehicle within safe distance.

Indirect cause: Failure of employee to pay attention to driving (defensive driving).

ACTION(S) TAKEN TO PREVENT RE-OCCURRENCE OR PROVIDE ON-GOING CORRECTIVE ACTIONS. Fully describe all the actions taken, anticipated, and recommended to eliminate the cause(s) and prevent reoccurrence of similar accidents/illnesses. Continue on back or additional sheets of paper if necessary to fully explain and attach to the complete report form.

CORRECTIVE ACTION DATES -

(1) Beginning - Enter the date when the corrective action(s) identified above will begin.

(2) Anticipated Completion - Enter the date when the corrective action(s) identified above will be completed.

PERSONAL PROTECTIVE EQUIPMENT (PPE) - Mark appropriate box(es) and list PPE which was being used by the injured person at the time of the accident (e.g. protective clothing, shoes, glasses, goggles, respirator, safety belt, harness, etc.)

TYPE OF CONTRACTOR EQUIPMENT - Enter the Serial Number, Model Number and specific type of equipment involved in the mishap (e.g. dump truck (off highway), crane (rubber tire), pump truck (concrete), etc.).

WAS HAZARDOUS MATERIAL SPILLED/RELEASED? - Mark appropriate block and list name(s) of any reportable quantities of hazardous materials spilled/released during the mishap.

WHO PROVIDED FIRST AID OR CLEAN-UP OF MISHAP SITE? - List name(s) of individual(s) and employer, if known.

ANY BLOOD-BORNE PATHOGEN EXPOSURE, OTHER THAN EMT? - Mark appropriate block and list name(s) of individual(s) and employer, if known.

LIST OSHA AND/OR EM 385-1-1 STANDARDS THAT WERE VIOLATED. - Self explanatory.

WAS SITE SECURED AND WITNESS STATEMENT TAKEN IMMEDIATELY? - Mark appropriate block and list by whom.

SECTION 6 - INJURY/ILLNESS/FATALITY INFORMATION

SEVERITY OF INJURY/ILLNESS - Mark appropriate box.

ESTIMATED DAYS LOST - Enter the estimated number of workdays the person will lose from work. Update when final data is known.

ESTIMATED DAYS HOSPITALIZED - Enter the estimated number of workdays the person will be hospitalized. Update when final data is known.

ESTIMATED DAYS RESTRICTED DUTY - Enter the estimated number of workdays the person, as a result of the accident, will not be able to perform all of their regular duties. Update when final data is known.

BODY PART(S) AFFECTED - Enter the most appropriate primary and when applicable, secondary, etc. body part(s) affected (e.g. arm: wrist: abdomen: single eye: jaw: both elbows: second finger: great toe: collar bone: kidney, etc.).

NATURE OF INJURY/ILLNESS FOR PRIMARY BODY PART - Enter the most appropriate nature of injury/illness (e.g. amputation, back strain, dislocation, laceration, strain, asbestosis, food poisoning, heart conditions, etc.).

TYPE AND SOURCE OF INJURY/ILLNESS - Type and Source Codes are used to describe what caused the incident.

(1) **TYPE** Code stands for an "Action" (Example: Worker, installing conduit, lost his balance and fell five feet from a ladder. Type Code: Fell different levels".) Select the most appropriate Type of injury from the list below:

TYPE OF INJURY/ILLNESS

STRUCK BY/AGAINST	CONTACTED CONTACTED WITH (INJURED PERSON MOVING) CONTACTED BY (OBJECT WAS MOVING)
FELL, SLIPPED, TRIPPED SAME LEVEL/DIFFERENT LEVEL/NO FALL	EXERTED LIFTED, STRAINED BY (SINGLE ACTION) STRESSED BY (REPEATED ACTION)
CAUGHT ON/IN/BETWEEN	EXPOSED INHALED/INGESTED/ABSORBED/EXPOSED TO
PUNCTURED, LACERATED PUNCTURED BY/CUT BY/STUNG BY/BITTEN BY	TRAVELING IN

(2) **SOURCE** Code stands for an "object or substance." (Example: Worker, installing conduit, lost his balance and fell five feet from a ladder. Source Code: "Ladder".) Select the most appropriate Source of injury from the list below:

SOURCE OF INJURY/ILLNESS

BUILDING OR WORKING AREA WALKING/WORKING AREA STAIRS/STEPS LADDER FURNITURE BOILER/PRESSURE VESSEL EQUIPMENT LAYOUT WINDOWS/DOORS ELECTRICITY	DUST, VAPOR, ETC. DUST (SILICA, COAT, ETC.) FIBERS ASBESTOS GASES CARBON MONOXIDE MIST, STEAM, VAPOR, FUME WELDING FUMES PARTICLES (UNIDENTIFIED)
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ENVIRONMENT CONDITION TEMPERATURE EXTREME (INDOOR) WEATHER (ICE, RAIN, HEAT, ETC.) FIRE, FLAME, SMOTE (NOT TABACCO) NOISE RADIATION LIGHT VENTILATION TOBACCO SMOKE STRESS (EMOTIONAL) CONFINED SPACE	CHEMICAL, PLASTIC, ETC. DRY CHEMICAL - CORROSIVE DRY CHEMICAL - TOXIC DRY CHEMICAL - EXPLOSIVE DRY CHEMICAL - FLAMMABLE LIQUID CHEMICAL - CORROSIVE LIQUID CHEMICAL - TOXIC LIQUID CHEMICAL - EXPLOSIVE LIQUID CHEMICAL - FLAMMABLE PLASTIC WATER MEDICINE
MACHINE OR TOOL HAND TOOL (POWERED: SAW, GRINDER, ETC.) HAND TOOL (NON POWERED) MECHANICAL POWER TRANSMISSION APPARATUS GUARD, SHIELD (FIXED, MOVEABLE, INTERLOCK) VIDEO DISPLAY TERMINAL PUMP, COMPRESSOR, AIR PRESSURE TOOL HEATING EQUIPMENT WELDING EQUIPMENT	INANIMATE OBJECT BOX, BARREL, ETC. PAPER METAL ITEM, MINERAL NEEDLE GLASS SCRAP, TRASH, WOOD FOOD CLOTHING, APPAREL, SHOES
MACHINE OR TOOL HAND TOOL (POWERED: SAW, GRINDER, ETC.) HAND TOOL (NON POWERED) MECHANICAL POWER TRANSMISSION APPARATUS GUARD, SHIELD (FIXED, MOVEABLE, INTERLOCK) VIDEO DISPLAY TERMINAL PUMP, COMPRESSOR, AIR PRESSURE TOOL HEATING EQUIPMENT WELDING EQUIPMENT	INANIMATE OBJECT BOX, BARREL, ETC. PAPER METAL ITEM, MINERAL NEEDLE GLASS SCRAP, TRASH, WOOD FOOD CLOTHING, APPAREL, SHOES
VEHICLE AS DRIVER OF PRIVATELY OWNED, RENTAL VEH. AS PASSENGER OF PRIVATELY OWNED, RENTAL VEH. DRIVER OF GOVERNMENT VEHICLE PASSENGER OF GOVERNMENT VEHICLE COMMON CARRIER (AIRLINE, BUS, ETC.) AIRCRAFT (NOT COMMERCIAL) BOAT, SHIP, BARGE	ANIMATE OBJECT DOG OTHER ANIMAL PLANT INSECT HUMAN (VIOLENCE) HUMAN (COMMUNICABLE DISEASE) BACTERIA, VIRUS (NOT HUMAN CONTACT)
MATERIAL HANDLING EQUIPMENT EARTHMOVER (TRACTOR, BACKHOE, ETC.) CONVEYOR (FOR MATERIAL AND EQUIPMENT) ELEVATOR, ESCALATOR, PERSONNEL HOIST HOIST, SLING CHAIN, JACK CRANE FORKLIFT HANDTRUCK, DOLLY	PERSONAL PROTECTIVE EQUIPMENT PROTECTIVE CLOTHING, SHOES, GLASSES, GOGGLES RESPIRATOR, MASK DIVING EQUIPMENT SAFETY BELT, HARNESS PARACHUTE

SECTION 7 - CAUSAL FACTORS

Review thoroughly. Answer each question by marking the appropriate block. **NOTE!** If any answer is yes, explain in section 5 above.

- (1) **DESIGN** - Did inadequacies associated with the building or work site play a role? Would an improved design or layout of the equipment or facilities reduce the likelihood of similar accidents? Were the tools or other equipment designed and intended for the task at hand?
- (2) **INSPECTION/MAINTENANCE** - Did inadequately or improperly maintained equipment, tools, workplace, etc., create or worsen any hazards that contributed to the accident? Would better equipment, facility, work site or work activity inspections have helped avoid the accident?
- (3) **PERSONS PHYSICAL CONDITION** - Do you feel that the accident would probably not have occurred if the employee was in "good" physical condition? If the person involved in the accident had been in better physical condition, would the accident have been less severe or avoided altogether? Was overexertion a factor?
- (4) **OPERATION PROCEDURES** - Did lack of or inadequacy within established operating procedures contribute to the accident? Did any aspect of the procedures introduce any hazard to, or increase the risk associated with the work process? Would establishment or improvement of operating procedures reduce the likelihood of similar accidents?
- (5) **JOB PRACTICES** - Were any of the provision of the Safety and Health Requirements Manual (EM 385-1-1) violated? Was the task being accomplished in a manner which was not in compliance with an established job hazard analysis or activity hazard analysis? Did any established job practice (including EM 385-1-1) fail to adequately address the task or work process? Would better job practices improve the safety of the task?
- (6) **HUMAN FACTORS** - Was the person under undue stress (either internal or external to the job)? Did the task tend toward overloading the capabilities of the person: i.e., did the job require tracking and reacting to many external inputs such as displays, alarms, or signals? Did the arrangement of the workplace tend to interfere with efficient task performance? Did the task require reach strengths, endurance, agility, etc., at or beyond the capabilities of the employee? Was the work environment ill-adapted to the person? Did the person need more training, experience, or practice in doing the task? Was the person inadequately rested to perform safely?
- (7) **ENVIRONMENTAL FACTORS** - Did any factors such as moisture, humidity, rain, snow, sleet, hail, ice, fog, cold, heat, sun temperature changes, wind, tides, floods, currents, terrain; dust, mud, glare, pressure changes, lighting, etc., play a part in the accident?

(8) **CHEMICAL AND PHYSICAL AGENT FACTORS** - Did exposure to chemical agents (either single shift exposure or long-term exposure such as dusts, fibers, (asbestos, etc.), silica, gases (carbon monoxide, chlorine, etc.), mists, steam, vapors, fumes, smoke, other particulates, liquid or dry chemicals that are corrosive, toxic, explosive or flammable, by-products of combustion or physical agents such as noise, ionizing radiation, non-ionizing radiation (UV radiation created during welding, etc.) contribute to the accident/incident?

(9) **OFFICE FACTORS** - Did the fact that the accident occurred in an office setting or to an office worker have a bearing on its cause? For example, office workers tend to have less experience and training in performing tasks such as lifting office furniture. Did physical hazards within the office environment contribute to the hazard?

(10) **SUPPORT FACTORS** - Was the person using an improper tool for the job? Was inadequate time available or utilized to safely accomplish the task? Were less than adequate personnel resources (in terms of employee skills, number of workers, and adequate supervision) available to get the job done properly? Was funding available, utilized and adequate to provide proper tools, equipment, personnel, site preparation, etc.

(11) **PERSONAL PROTECTIVE EQUIPMENT** - Did the person fail to use appropriate personal protective equipment (gloves, eye protection, hard-toed shoes, respirator, etc) for the task or environment? Did protective equipment provided or worn fail to provide adequate protection from the hazard(s)? Did lack of or inadequate maintenance of protective gear contribute to the accident?

(12) **DRUGS/ALCOHOL** - Is there any reason to believe the person's mental or physical capabilities, judgment, etc., were impaired or altered by the use of drugs or alcohol? Consider the effects of prescription medicine and over the counter medications as well as illicit drug use. Consider the effect of drug or alcohol induced "hangovers".

(13) **JOB/ACTIVITY HAZARD ANALYSIS** - Was a written Job/Activity Analysis completed for the task being performed at the time of the accident? If one was made, did it address the hazard adequately or does it need to be updated? If none made, will one be made? These may also need to be addressed in the Corrective Actions Taken section. Mark the appropriate box. If one was made, attach a copy of the analysis to the report.

(14) **MANAGEMENT** - Did the lack of supervisor or management support play a part in the mishap? Mark the appropriate box.

SECTION - 8 OSHA INFORMATION - Complete this section if applicable

SECTION 9 - REPORT PREPARER

Providing a completed CSIR to the Contracting Officer is the **PRIME CONTRACTOR'S RESPONSIBILITY**. Enter the name, date of report, title, employer, phone number and signature of person completing the accident report and provide it to the Contracting Officer, or his representative, responsible for oversight of that contractor activity. **NOTE!** If prepared by other than the Prime Contractor, a person employed by the Prime Contractor must sign that they have reviewed and concur with the report and it's findings (e.g. company owner, project supervisor/foreman, Safety Officer, etc.).